AL/OE-TR-1996-0080

CONTROL EFFICIENCY DETERMINATION OF SUDDEN EXPANSION INCINERATOR BLDG 348, KELLY AFB, TEXAS

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Final Technical Report for the Period 19 July 1995 to 11 January 1996

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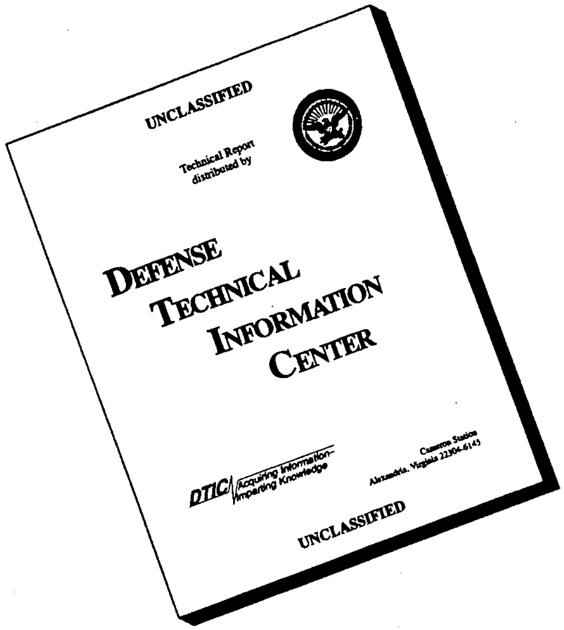

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13. ABSTRACT *(Maximum 200 words)*

Compliance emissions testing and Volatile Organic Compound (VOC) destruction efficiency determination were conducted on the Sudden Expansion (SUE) Incinerator located at the Kelly AFB Fuel Accessory Test Facility, Bldg 348. Compliance standards and requirements are found in Operating Permit No. 6493, as amended/renewed by the State of Texas on 24 March 1994. The purpose of the Kelly AFB SUE Incinerator is to destroy calibration fluid vapors emitted from fuel accessory test stands located in Bldg 348. The incinerator can also be used to destroy liquid waste calibration fluid by burning it as a supplemental fuel. Emissions testing was conducted during combustion of both vapors and liquid calibration fluid. For purposes of determining the incinerator VOC destruction efficiency, monitoring for Total VOC concentration in the inlet air stream was conducted on 19-20 July 1995. Emissions testing of the incinerator exhaust was conducted on 10-11 January 1996 and included monitoring for Total VOC, oxides of nitrogen (NOx), carbon monoxide (CO), and visible emissions. Results indicate that the SUE Incinerator is in compliance with all applicable emission standards and with the VOC destruction efficiency requirement.

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VOC destruction efficiency   Test stands   Calibration fluid   Inlet duct   Exhaust stack

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INTRODUCTION

Background

On 19-20 Jul 95 and 10-11 Jan 96, emissions testing was conducted on the Sudden Expansion (SUE) Vapor Incinerator located at the Kelly AFB Fuel Accessory Test Facility (Bldg 348). Testing was performed by the Air Quality Function of the Air Force Armstrong Laboratory. This survey was requested by the Kelly AFB Environmental Management Office to satisfy State of Texas permit requirements. Pollutants monitored during this survey included Total Volatile Organic Compounds (VOC), Oxides of Nitrogen (NO_x), and Carbon Monoxide. Personnel involved with on-site testing are listed in Appendix A.

Site Description

The Kelly AFB Fuel Accessory Test Facility performs testing of F-100 unified fuel control and nozzle units. The inspection process involves passing a calibration fluid (Stoddard solvent, Military Specification MIL-C-7024D Type II) through fuel control units which are set up in functional test stands. Information on the calibration fluid is found in Appendix B. The test stands are large computer-controlled modules which simulate actual operation of the fuel control assemblies.[1,2,3] There are currently 57 test stands located in Bldg 348. Figure 1 provides a layout of Bldg 348's 1st floor showing the locations of the test stands. A view of a typical test stand is shown in Figure 2.

At each test stand, fuel control units are tested directly over a sink equipped with a down draft ventilation system. The calibration fluid used for testing is pumped from a 500 gallon (gal) reservoir located at each test stand. Testing of the fuel control units is accomplished using one of two configurations, closed loop or open body, depending on which section of the fuel control assembly is being tested. In the closed loop configuration, calibration fluid is pumped through the fuel control unit in a closed system. After the test is completed, the flow control unit is disconnected from the test stand and any residual calibration fluid is dumped into the sink. In the open body configuration, calibration fluid is continuously pumped through the fuel control unit and directly into the sink.[1,2]

Calibration fluid dumped into the test stand sink is drained back into the 500 gal reservoir. The fluid in the reservoir is

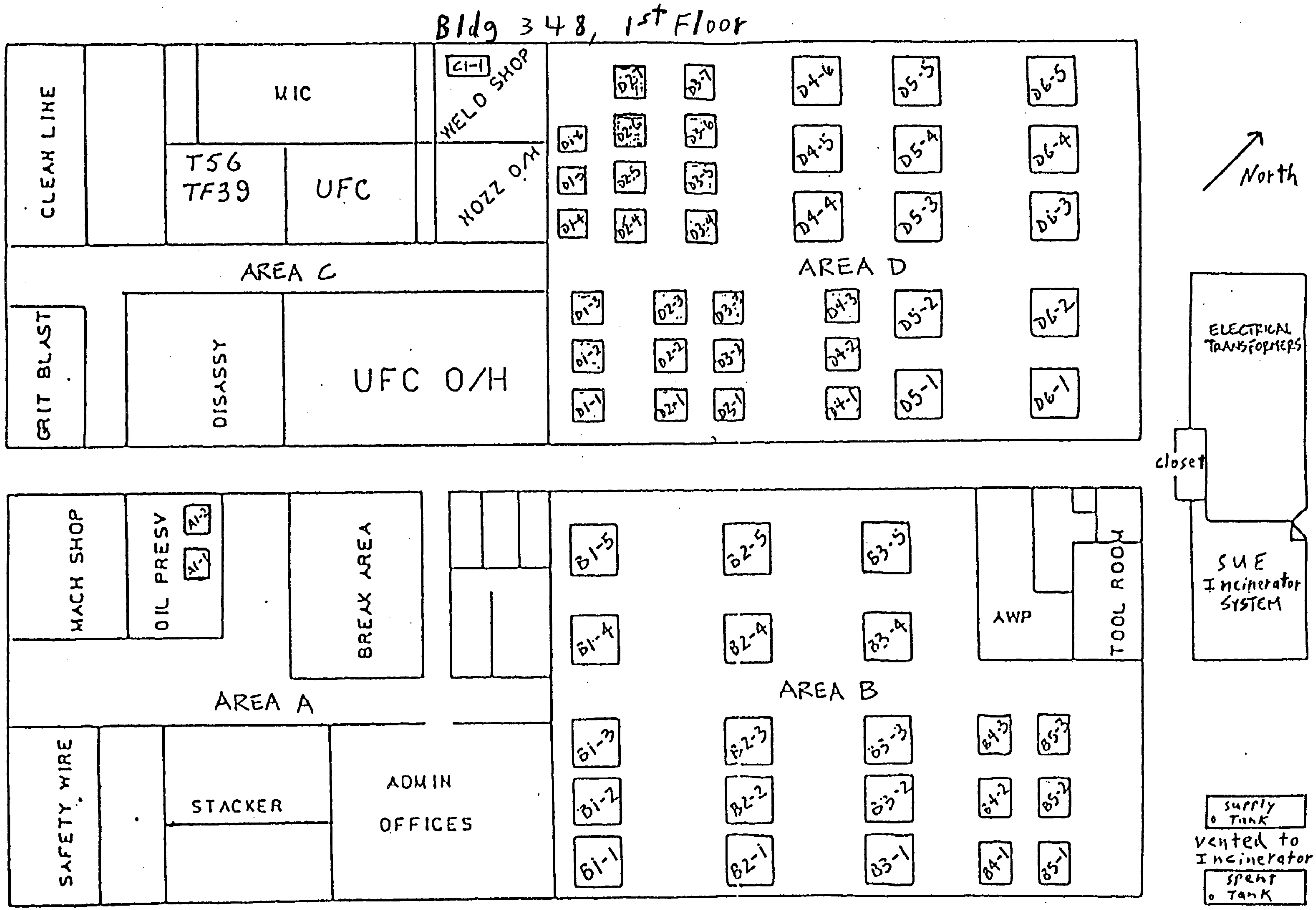

Figure 1. Locations of Test Stands.

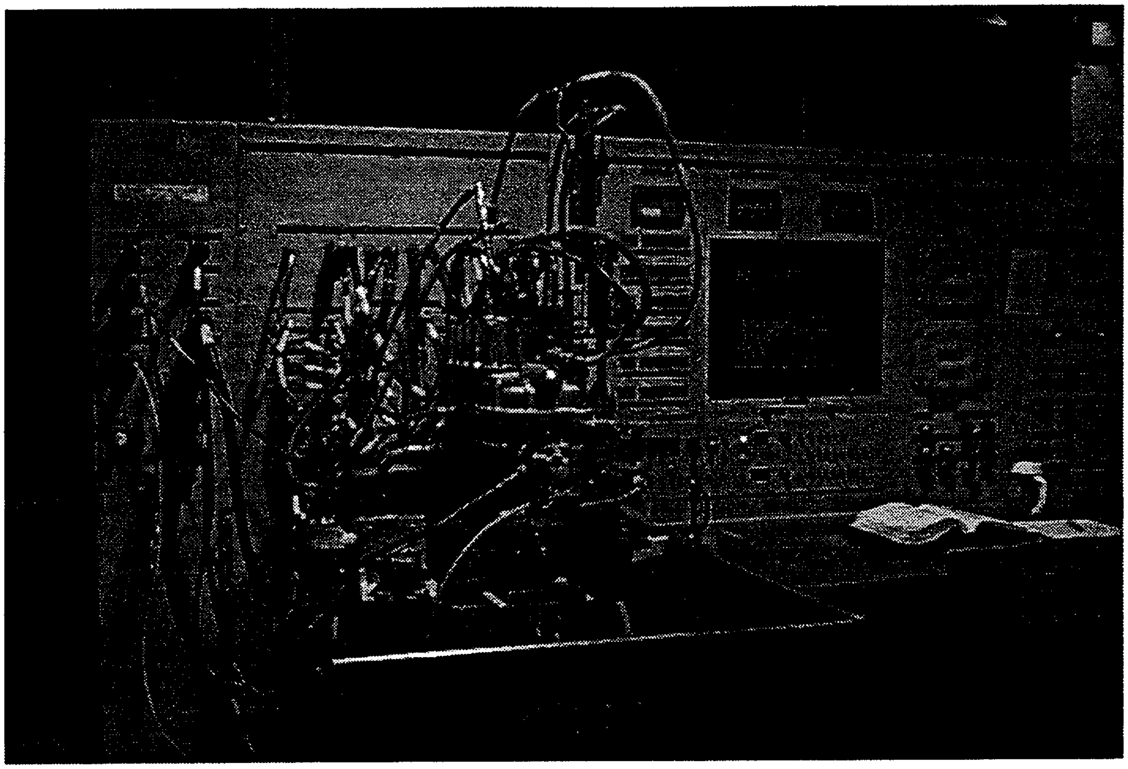

Figure 2. View of a Typical Test Stand.

reused for testing until the lab determines (through visual, specific gravity, and viscosity tests) that the fluid is unuseable, at which point it is considered spent (waste) fluid.[3] The spent calibration fluid is then drained out and replaced with clean fluid. Vapors from the calibration fluid dumped into the sink are captured by the ventilation system. 24 of the 57 test stands are ventilated to the SUE Incinerator while the other 33 test stands are vented to the atmosphere.

The calibration fluid used for testing the fuel control units is stored in two 20,000 gal underground storage tanks located at the northeast side of Bldg 348 (see Fig. 1). One tank supplies the clean fluid to the 500 gal reservoirs while the other tank receives the spent fluid drained from the reservoirs. Both tanks are vented to the sink vapor air entering the SUE Incinerator system.[1,2,3] A flow diagram showing calibration fluid use at a typical test stand is presented in Figure 3.

A Robinson Industries blower is used to draw calibration fluid vapors through the ventilation system and into the SUE Incinerator. The blower is rated at 20,000 standard cubic feet per minute (SCFM) and 250 horsepower (hp).[3] A flow diagram showing the vapor ventilation system is presented in Figure 4.

The SUE Incinerator (Model F20,000 manufactured by Kaiser Marquardt) consists of four 5,000 SCFM stainless steel burners equipped with integral recuperative heat exchangers which pre-heat incoming air. The incinerator is located in the courtyard on the northeast side of Bldg 348 (see Fig. 1). A view of the SUE Incinerator is shown in Figure 5. A schematic of a similar single burner SUE Incinerator (Model F5,000) is shown in Figure 6. Each burner of the SUE Incinerator includes a cylindrical combustion chamber which is joined to a smaller inlet pipe by a flat circular plate. Fuel nozzles protrude through the flat plate into the combustion chamber. The sudden expansion between the smaller inlet duct and the combustion chamber acts as a flame holder permitting stable combustion over a wide range of pressures, temperatures, and flows.[3] A schematic showing the combustion process within a typical burner is presented in Figure 7.

The SUE Incinerator is currently fueled with either natural gas or natural gas supplemented with waste calibration fluid. Although the State operating permit also allows Kelly AFB to use waste shelf life oil as a supplemental fuel, shelf life oil is currently not burned in the SUE Incinerator. The waste calibration fluid burned by the SUE Incinerator comes from the "Spent" 20,000 gal underground storage tank located at Bldg 348 and from a 30,000 gal aboveground storage tank located at Bldg

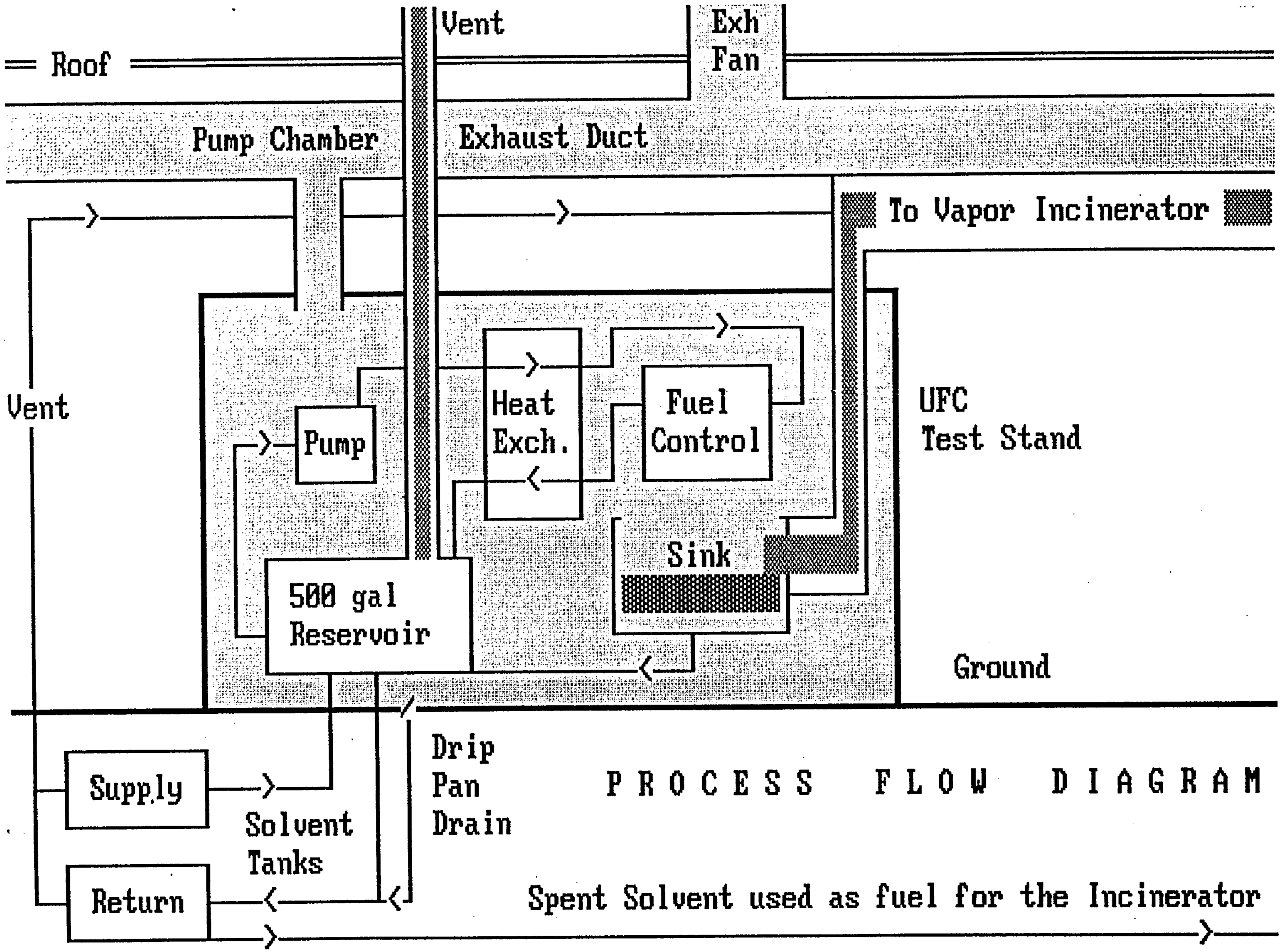

Figure 3. Flow Diagram of Calibration Fluid Use.

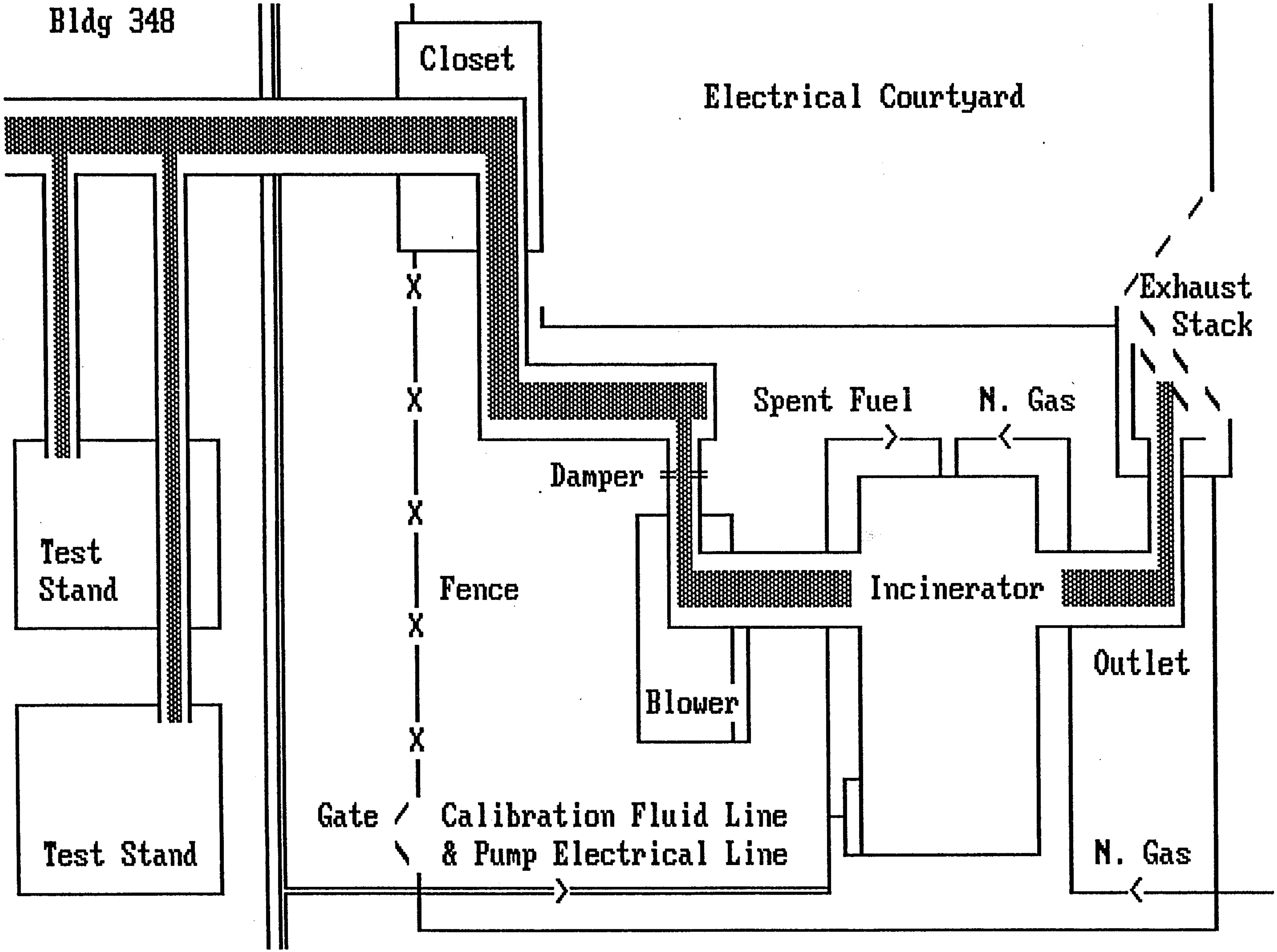

Figure 4. Flow Diagram of Vapor Ventilation System.

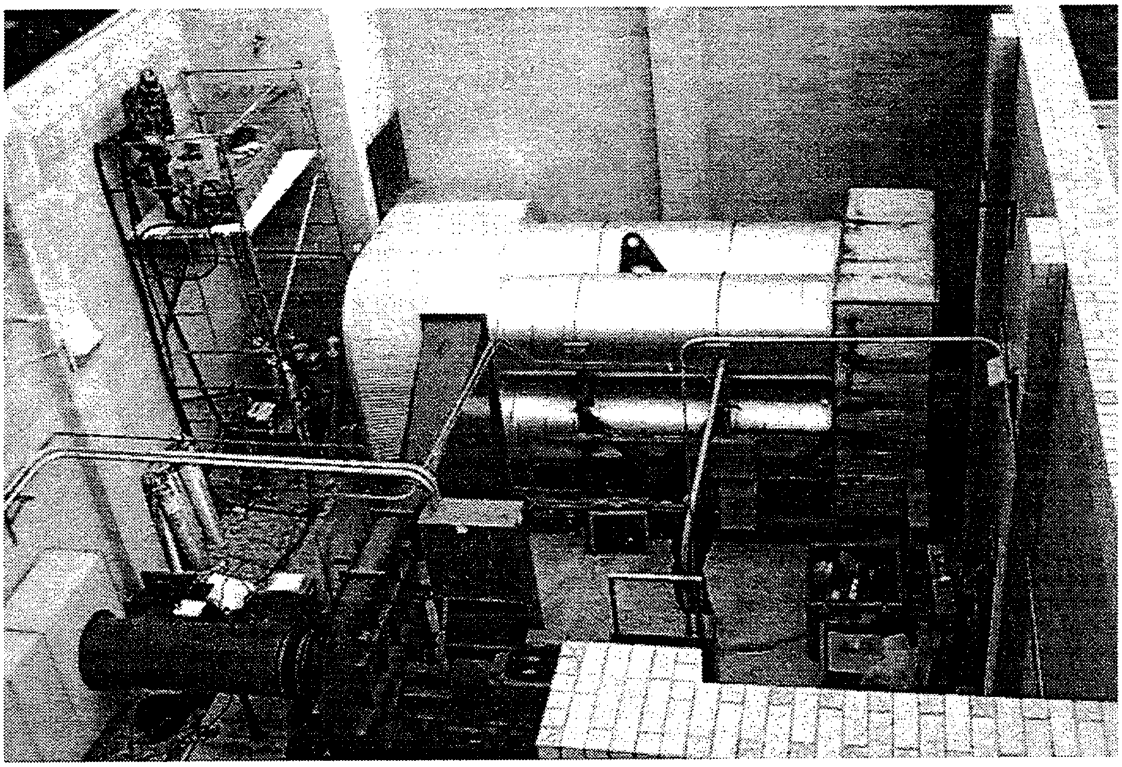

Figure 5. View of Kelly AFB's SUE Incinerator.

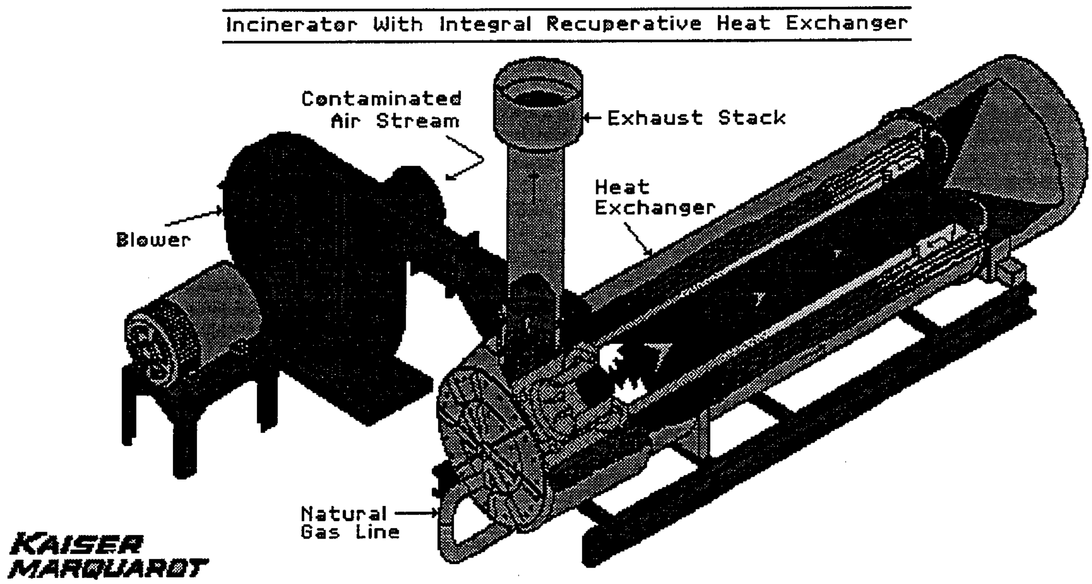

Figure 6. Schematic of a Model F5,000 SUE Incinerator.

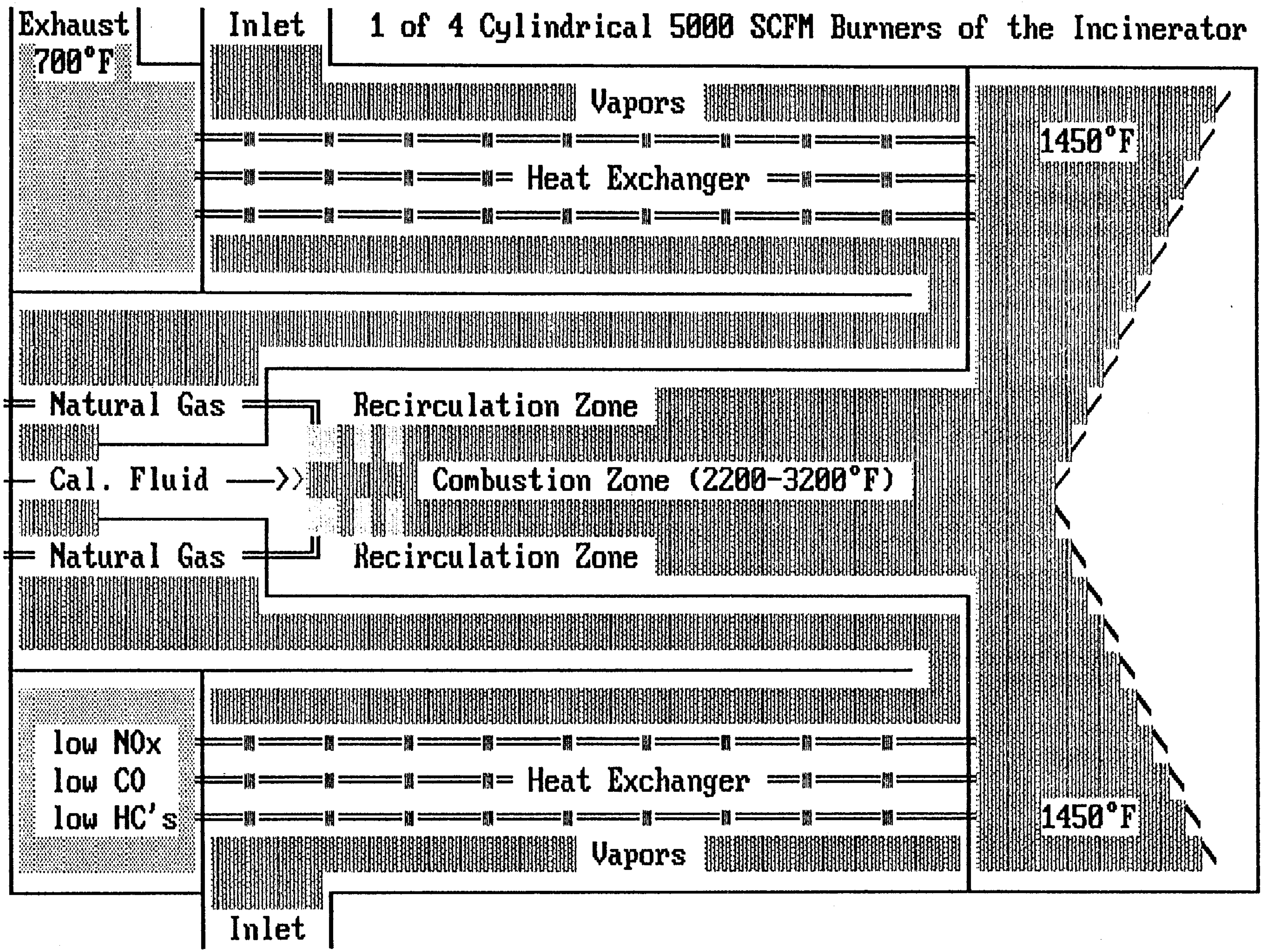

Figure 7. Schematic of Burner Combustion Process.

345.[3] A flow diagram showing fuel and vapor input into the SUE Incinerator is presented in Figure 8.

Applicable Standards and Guidelines

The emission standards, destruction efficiency, and operating requirements for the SUE Incinerator are specified in Texas Natural Resource Conservation Commission (TNRCC) Permit No. 6493, as amended/renewed on 24 Mar 94.[4] The entire permit is located in Appendix C and the major provisions applicable to the SUE Incinerator are summarized below:

1. The maximum allowable emission rates for VOC are 5.53 pounds per hour (lb/hr) and 24.20 tons per year (TPY).

2. The maximum allowable emission rates for NO_x are 7.69 lb/hr and 33.70 TPY.

3. The maximum allowable emission rates for CO are 21.80 lb/hr and 95.00 TPY.

4. Opacity of emissions from the SUE Incinerator stack must not exceed 5 percent averaged over a six-minute period.

5. A VOC destruction efficiency of 98 percent for the SUE Incinerator shall be demonstrated while burning Stoddard solvent and shelf life oils.

6. The exhaust exit gas temperature of the SUE Incinerator must be continuously monitored and recorded to ensure a minimum temperature of 1450°F is maintained whenever burning VOCs, Stoddard solvent, or shelf life oils.

7. Records listed under Item 10 of the permit (e.g., quantity of liquid fuel burned, hours of incinerator operation, incinerator temperature charts, etc.) shall be maintained for a period of 2 years.

METHODS AND MATERIALS

To determine compliance with the TNRCC Operating Permit, sampling was conducted on both the inlet and outlet sides of the SUE Incinerator. Sampling on the inlet side included measurements for VOC, moisture, temperature, and velocity determination. The velocity was multiplied by the cross-sectional area of the duct to calculate the duct gas flow rate. Sampling on the outlet (exhaust) side of the SUE Incinerator included measurements for VOC, NO_x, CO, Opacity, moisture, temperature, velocity, oxygen (O_2), and carbon dioxide (CO_2).

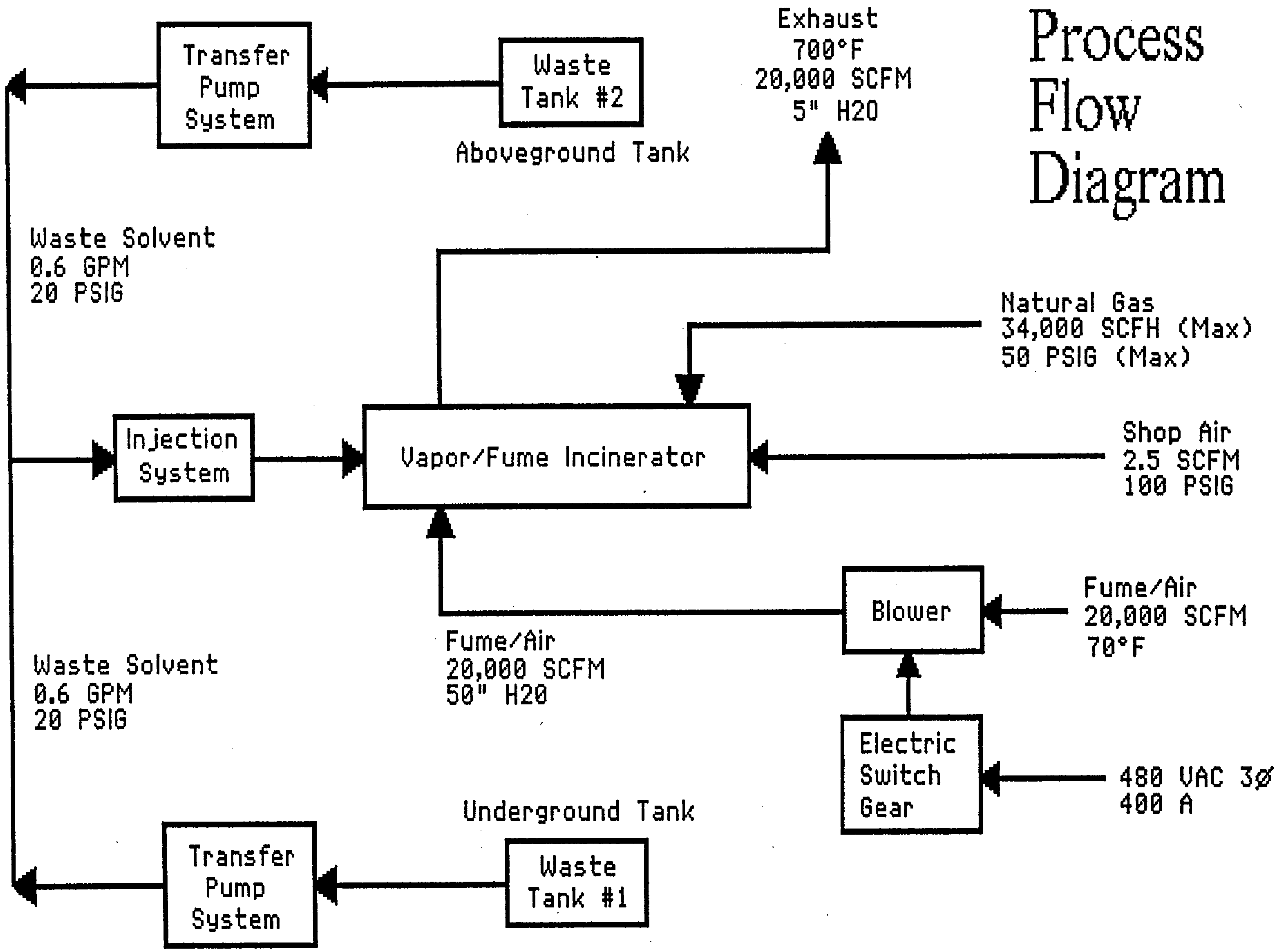

Figure 8. Flow Diagram of Fuel and Vapor Input into SUE Incinerator.

The stack gas velocity was multiplied by the cross-sectional area of the stack to calculate the stack gas flow rate. Measurements for moisture, O_2, and CO_2 were required for gas molecular weight determination. Field data from both the inlet and exhaust sampling are found in Appendix D.

The locations of the port holes and sampling points were determined using EPA Method 1. For velocity measurements, Method 1 requires the port holes to be located a minimum of 2 duct diameters downstream and 0.5 duct diameters upstream of the nearest flow disturbances. All EPA Methods used in this survey are found in 40 Code of Federal Regulations, Part 60 (40 CFR 60).[5]

Sampling of the inlet gas stream was performed on a horizontal rectangular duct which is 5' high, 2' wide, and 8' 7" long. This section of duct is located in a small room (closet) adjacent to the SUE Incinerator (see Fig. 1). The effective inside diameter of this section of duct was calculated to be 2.86 feet using the equation **2HW/(H+W)** where **H** equals the height and **W** equals the width. Four port holes, located on the same vertical plane, were used for measuring the velocity, temperature, and moisture. These four port holes are located approximately 5.75 feet (2.0 duct diameters) downstream from the nearest disturbance. A fifth port hole, located approximately 1.5 feet (0.52 duct diameters) downstream from the first four port holes, was used to monitor Total VOC. A view of the inlet duct sampling ports is shown in Figure 9. In accordance with EPA Method 1, a total of 16 sampling points were used for measuring the velocity, temperature, and moisture. Total VOC were measured at a single point in the cross-sectional center of the duct. Figure 10 shows the locations of the five port holes for the inlet duct. Figure 11 shows the locations of the 16 sampling points used for measuring the velocity, temperature, and moisture.

Sampling of the exhaust gas stream was performed on the 30' high vertical stack located in the same courtyard as the SUE Incinerator. A view of the exhaust stack is shown in Figure 12. The exhaust stack is triangular with the inside opening having two 4' sides and one 5.66' side. The effective inside diameter of this stack was calculated to be 2.34 feet using the equation **4A/P** where **A** equals the cross-sectional area and **P** equals the perimeter. Four port holes (located on the same horizontal plane) were used for measuring the velocity, temperature, and moisture. These port holes are located approximately 7 feet (3 stack diameters) downstream from the nearest disturbance (i.e., the horizontal exhaust duct connected to the side of the stack). A fifth port hole, located approximately 2 feet (0.85 stack diameters) above the first four port holes, was used to monitor the gaseous parameters (i.e., O_2, CO_2, NO_x, CO, and VOC). In

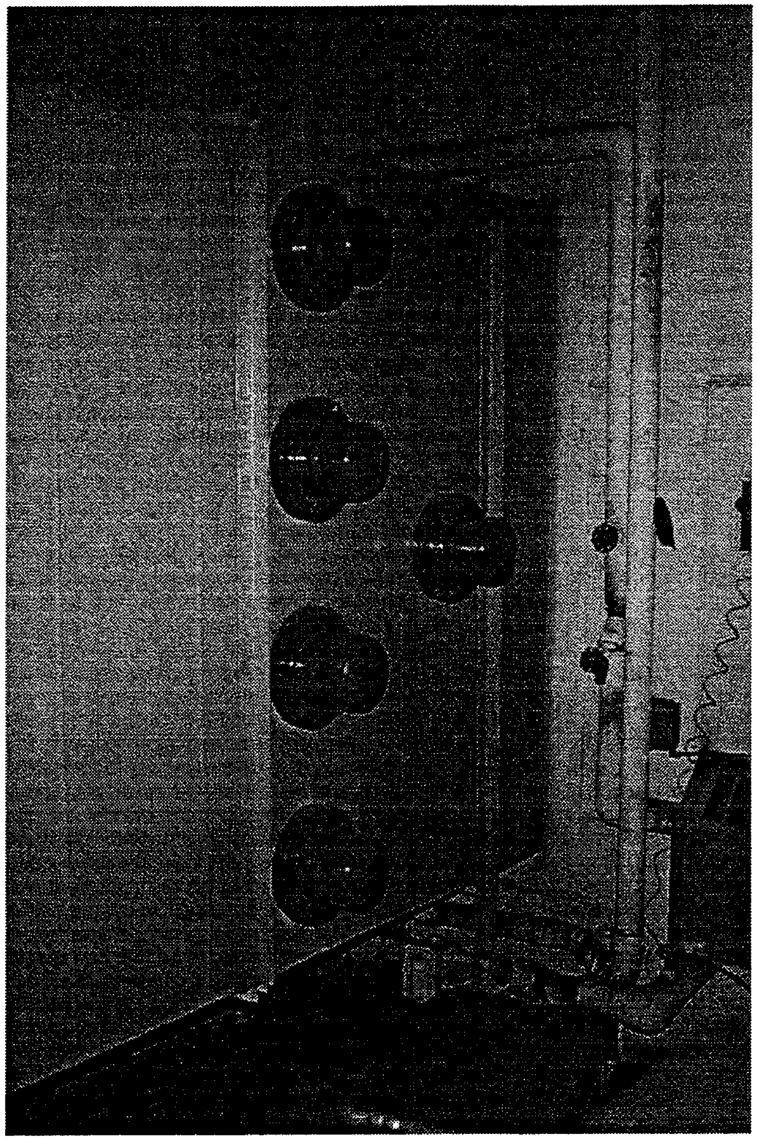

Figure 9. View of Inlet Duct Sampling Ports.

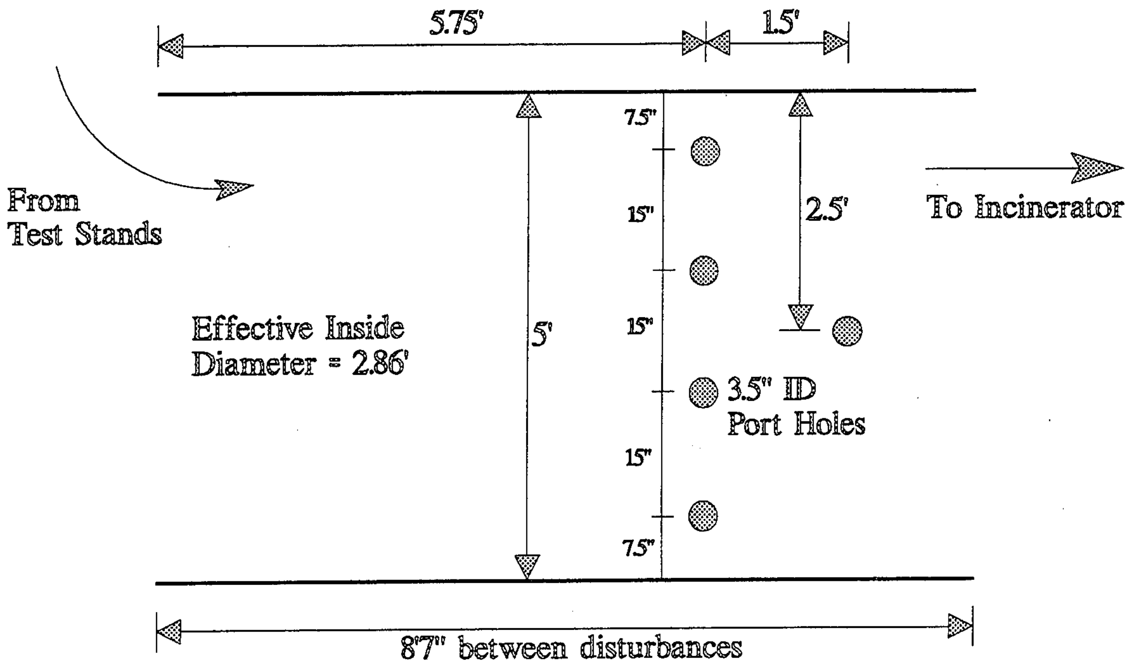

Figure 10. Locations of Inlet Duct Sampling Ports.

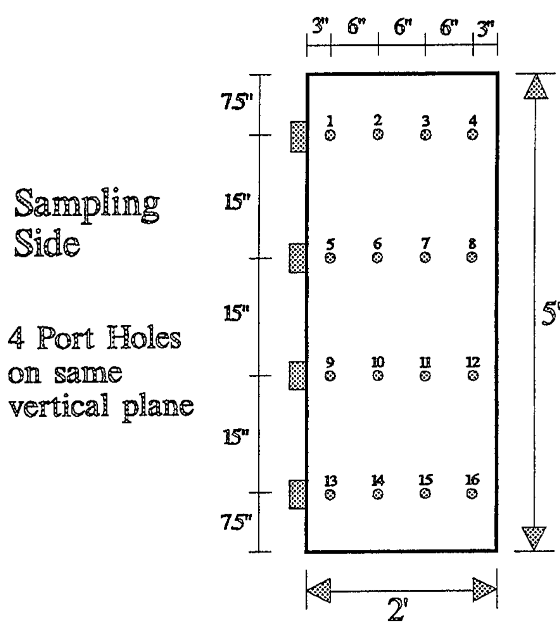

Figure 11. Locations of Inlet Duct Sampling Points for Velocity, Temperature, and Moisture.

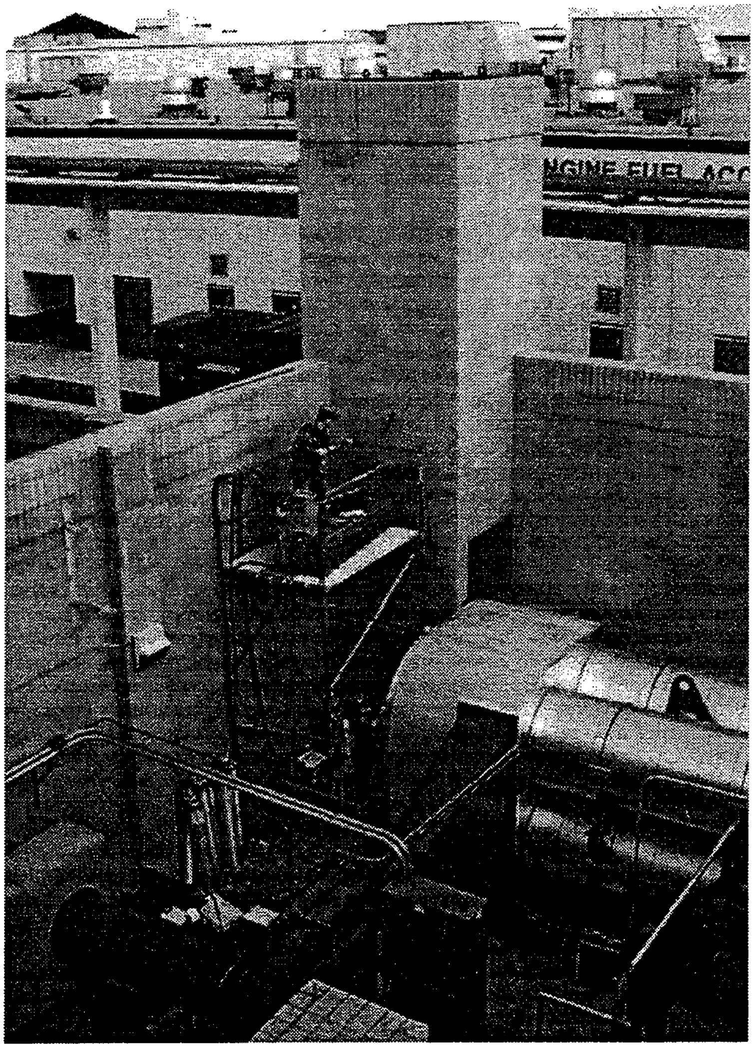

Figure 12. View of Exhaust Stack.

accordance with EPA Method 1, a total of 16 sampling points was used for measuring the velocity, temperature, and moisture. The concentrations of O_2, CO_2, NO_x, CO, and VOC were measured at a single point in the geometric cross-sectional center of the stack. Figure 13 shows the locations of the five port holes for the exhaust stack. Figure 14 shows the locations of the 16 sampling points used for measuring the velocity, temperature, and moisture.

Prior to sampling at both the inlet and outlet locations, the degree of cyclonic flow was determined by measuring the gas rotational angle at each of the 16 sampling points chosen for velocity, temperature, and moisture monitoring. Measurements were made using a Type S pitot tube, a 10-inch inclined-vertical manometer, an angle finder, and the procedures described in Paragraph 2.4 of EPA Method 1. Flow conditions are considered acceptable when the arithmetic mean average of the rotational angles is 20 degrees or less. Rotational angle measurements showed the air flow in both the inlet duct and exhaust stack to be within the acceptable limit. Preliminary velocity, temperature, and static pressure readings were also taken at the same time the cyclonic flow measurements were conducted.

The moisture, velocity, and temperature of the exhaust stack gas were determined using an EPA Method 5 sampling train. The train consisted of a button-hook probe nozzle, heated stainless steel probe, heated glass-fiber filter, impingers, and a pumping/metering device (meter box). A schematic of the Method 5 sampling train is shown in Figure 15 and a view of the meter box is shown in Figure 16. Calibration data for the Method 5 equipment are found in Appendix E. Calibrations were performed in accordance with EPA's Quality Assurance Handbook.[6] The probe nozzle was sized (with a micrometer) prior to sampling using EPA Method 5 criteria. Stack gas velocity pressure was measured at the nozzle tip using a Type S pitot tube connected to a 10-inch inclined-vertical manometer and the procedures described in EPA Method 2. Type K thermocouples were used to measure stack gas as well as sampling train temperatures. The probe liner was heated to minimize moisture condensation. The heated filter was used to filter out particulates prior to the impingers. The impinger train consisted of four glass impingers in series. The impinger train was placed in an ice bath which enabled the stack gas moisture to condense into the impingers. The first, third, and fourth impingers were of modified Greenburg-Smith design while the second impinger was a standard Greenburg-Smith type. The first and second impingers each contained 200 milliliters (ml) of distilled water, the third impinger was empty, and the fourth impinger contained 200 grams (g) of silica gel. The pumping and metering system was used to control and monitor the sample gas flow rate. In accordance with EPA Method 4, moisture sampling

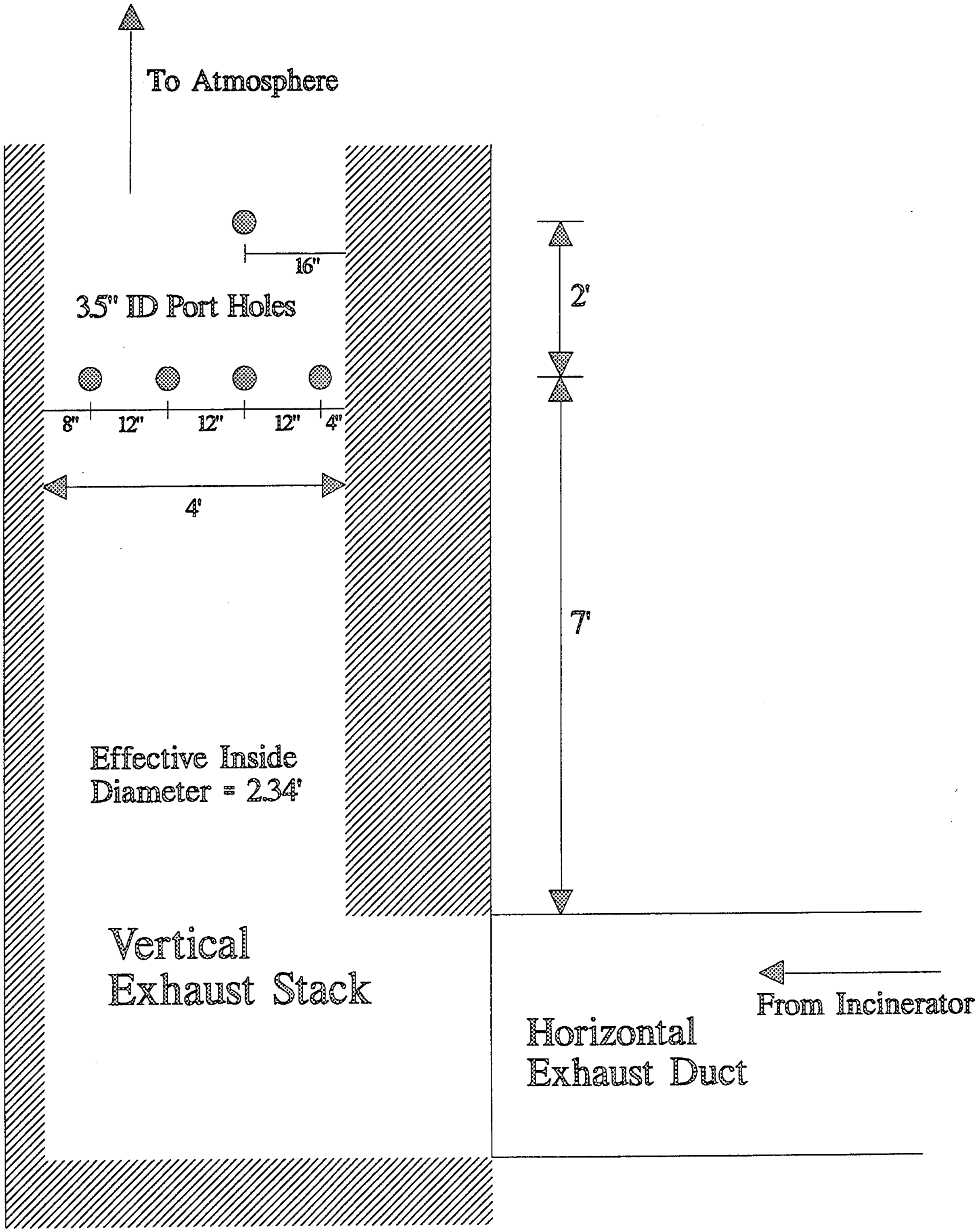

Figure 13. Locations of Exhaust Stack Sampling Ports.

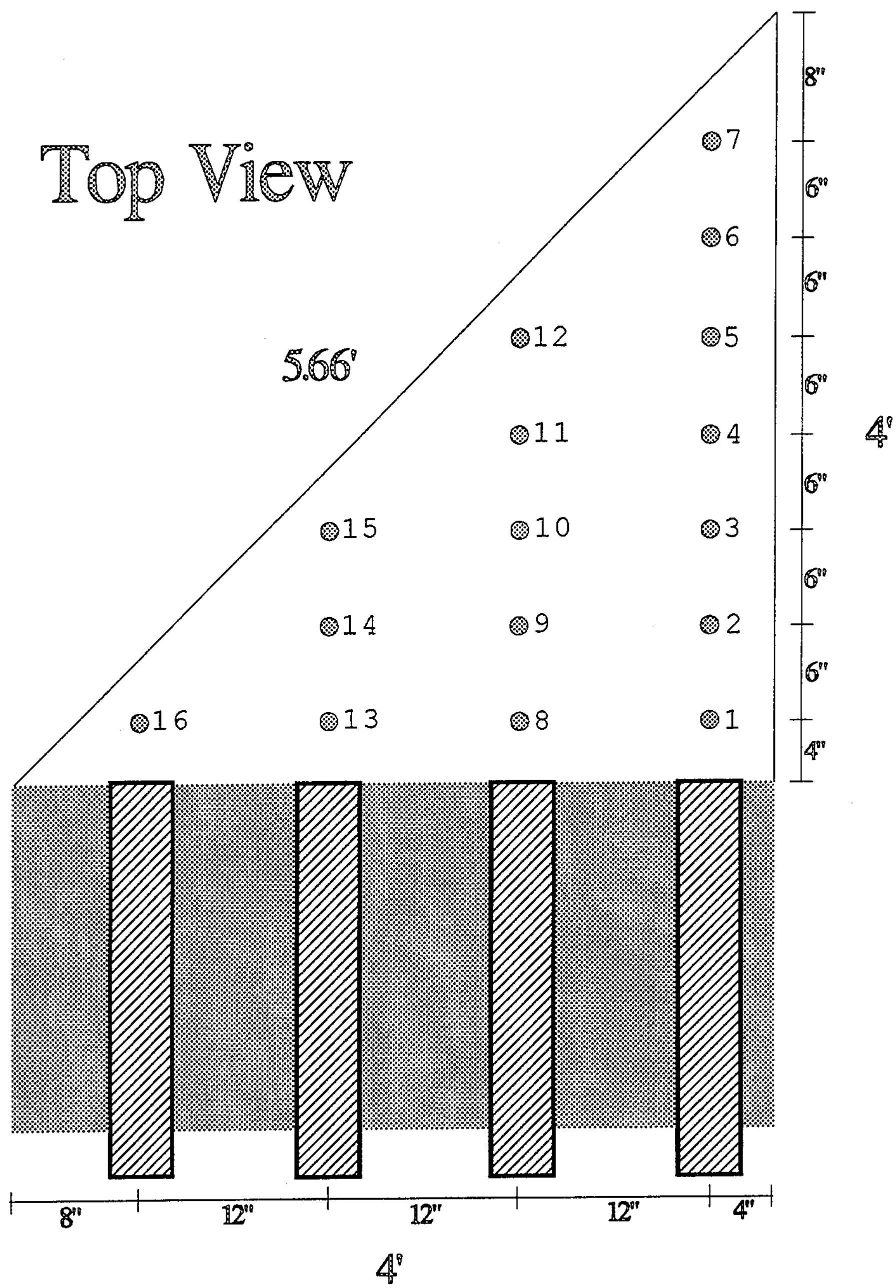

Figure 14. Locations of Exhaust Stack Sampling Points for Velocity, Temperature, and Moisture.

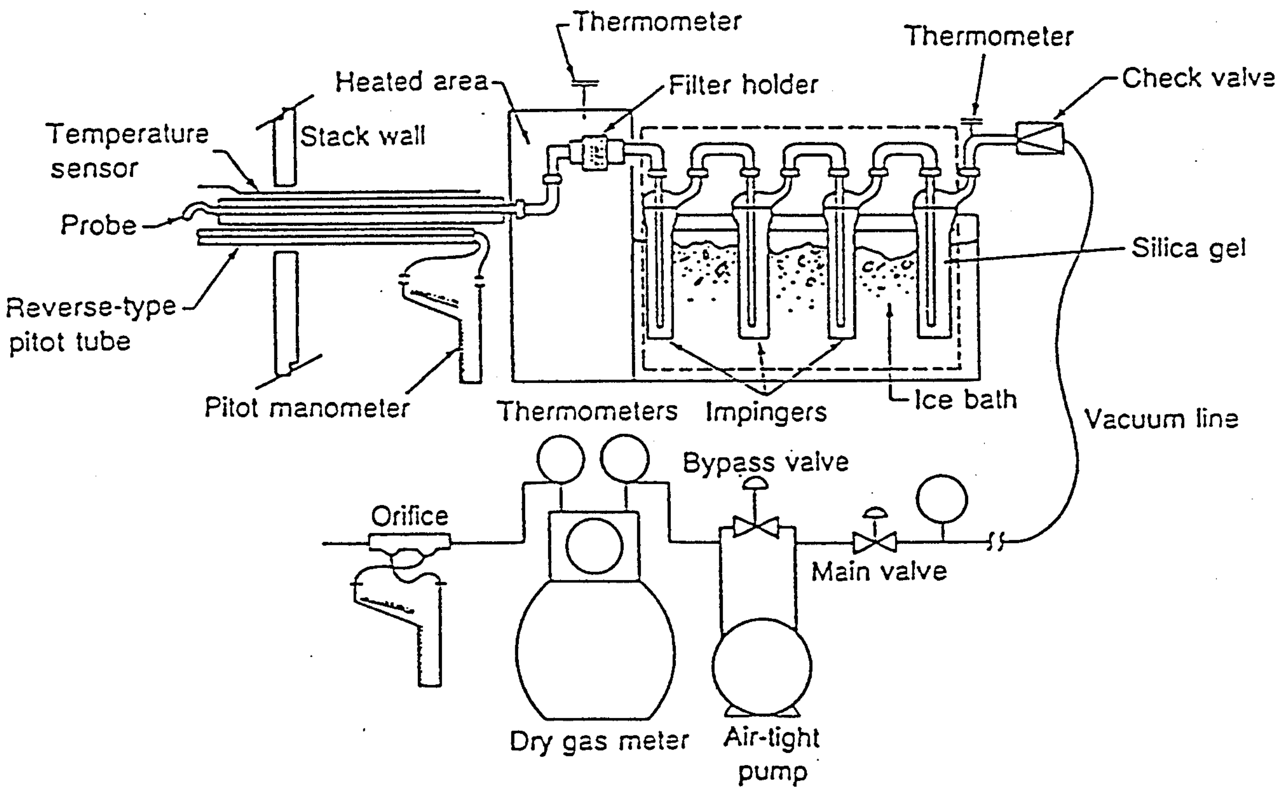

Figure 15. Schematic of Method 5 Sampling Train.

Figure 16. View of Meter Box.

was conducted at a constant flow rate and for an equal time (3.75 minutes) at each of the 16 sampling points. The velocity and flow rate of the stack gas were calculated using the EPA's HP 41 "METH 2" Calculator Program. The percent moisture of the exhaust stack gas was calculated using the EPA's Hewlett-Packard 41 (HP 41) "METH 4" Calculator Program.[7] Printouts from all the HP 41 programs run for this survey are found in Appendix F.

The moisture and temperature of the inlet duct gas were determined using wet bulb-dry bulb temperature readings. Measurements were taken at each of the 16 sampling points using mercury-in-glass thermometers. The percent moisture of the inlet duct gas was calculated using the EPA's HP 41 "WBDB" Calculator Program.

The velocity of the inlet duct gas was determined using a Type S pitot tube and a 10-inch inclined-vertical manometer. Calculations for the velocity and flow rate of the inlet duct gas were performed using the EPA's HP 41 "METH 2" Calculator Program.

The VOC concentration in both the inlet duct and exhaust stack gas was measured with a JUM Model 3-300A Flame Ionization Detector (FID) analyzer and the procedures described in EPA Method 25A. Prior to entering the analyzer, the sample gas traveled through a sampling system consisting of a heated stainless steel probe, a particulate filter, and a heated Teflon line. The sample was drawn through the system by a heated pump built into the analyzer. A 40% Hydrogen/60% Helium gas mixture was used as the fuel for the FID. A view of the VOC analyzer is shown in Figure 17. Information on the VOC analyzer, including calibration procedures, is found in Appendix G. A member of the survey team recorded VOC concentration measurements at 1-minute intervals during each sampling run. Measurements were in units of parts per million by volume (ppmv) as propane. The average VOC concentration for each sampling run was later converted to a mass emission rate in pounds per hour (lb/hr) using the following equation:

$$E = (C) \times (MW) \times (FR) \times (1.55\times10^{-7}) \qquad \textbf{(1)}$$

Where,

E = The pollutant emission rate in pounds per hour (lb/hr) [Note - VOC emission rate is reported as propane].

C = The measured pollutant concentration in ppmv.

MW = The molecular weight of the pollutant [Note - for VOC, the molecular weight of the calibration gas (propane) is used].

FR = The flow rate of the stack (or duct) gas in DSCFM.

1.55×10^{-7} = Conversion Factor $[(\text{min}\cdot\text{g-mole}\cdot\text{lb})/(\text{hr}\cdot\text{g}\cdot\text{ft}^3)]$

Initial plans were to sample for NO_x, O_2, and CO_2 in the exhaust stack gas with a Continuous Emission Monitoring (CEM) system manufactured by the Anarad Corporation. This system includes a sample conditioning/flow control module, a chemiluminescent NO_x analyzer, an infrared CO_2 analyzer, and an electrochemical O_2 analyzer. Unfortunately, because of mechanical problems with the sample flow control module, the analyzers could not be properly calibrated. Therefore, sampling for these parameters was instead accomplished using a backup method consisting of an ENERAC 3000 portable analyzer. This analyzer uses an electrochemical cell to measure O_2 concentration. NO_x concentration is computed by the analyzer by adding together the concentrations of nitric oxide (NO) and nitrogen dioxide (NO_2), both of which are measured via electrochemical cells. The analyzer computes CO_2 based on the O_2 content and the type of combustion fuel. A member of the survey team recorded NO_x, O_2 and CO_2 concentration measurements at 2-minute intervals during each sampling run. O_2 and CO_2 measurements were in units of percent while NO_x measurements were in units of ppm as NO_2. The average NO_x concentration for each sampling run was later converted to a mass emission rate (lb/hr) using Equation 1. A view of the ENERAC 3000 analyzer is shown in Figure 18. Specifications and information, including calibration procedures, for the ENERAC 3000 analyzer are found in Appendix H.

Sampling for CO in the exhaust stack gas was attempted using an Anarad Model AR-411 non-dispersive infrared (NDIR) analyzer. However, due to excessive drift, this instrument was not used. Instead, CO was determined using the ENERAC 3000 analyzer. The analyzer measures CO concentration via an electrochemical cell. A member of the survey team recorded CO concentration measurements at 2-minute intervals during each sampling run. Measurements were in units of ppm. The average CO concentration for each sampling run was later converted to a mass emission rate (lb/hr) using Equation 1.

The rate of liquid waste calibration fluid (lb/hr Stoddard solvent) combusted in the SUE Incinerator during each sampling run was recorded from the incinerator's main console.

The VOC destruction efficiency of the SUE Incinerator was calculated using the following equation:

$$DE = [(CF - E_{ex})/CF] \times 100 \qquad \textbf{(2)}$$

Where,

DE = Destruction Efficiency (%)
CF = Calibration Fluid combusted by SUE Incinerator (lb/hr as Stoddard solvent) [Note - includes both the VOC vapors in the inlet gas stream and the liquid waste calibration fluid

Figure 17. View of VOC Analyzer.

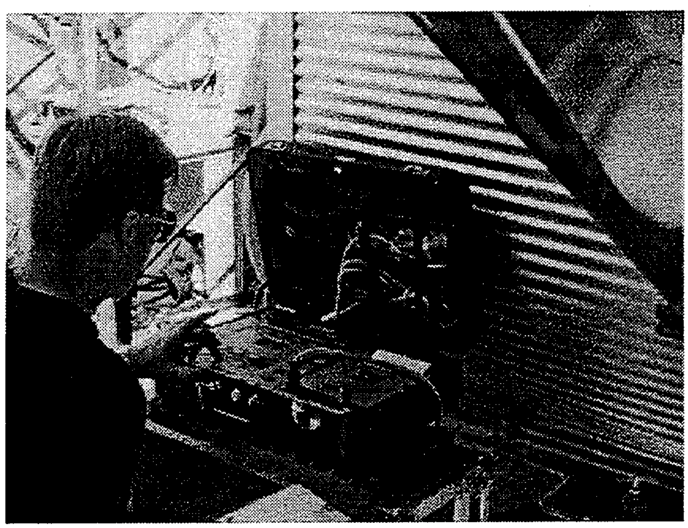

Figure 18. View of ENERAC 3000 Analyzer.

burned as supplemental fuel]

E_{ex} = VOC emission rate in exhaust stack (lb/hr as Stoddard solvent)

The VOC destruction efficiency was calculated based on the total Stoddard solvent burned by the incinerator. This includes the VOC vapors in the inlet gas stream (i.e., vapors removed from the test stands in Building 348) and the liquid waste Stoddard solvent burned as a supplemental fuel. Since the liquid waste solvent is included, it was necessary to convert both the inlet VOC vapor concentration and the exhaust VOC concentration from "ppmv as propane" to "ppmv as Stoddard solvent." This was done by first converting "ppmv as propane" to "ppmv as carbon" by multiplying by 3 (the carbon equivalent correction factor) in accordance with EPA Method 25A.[5] The concentration in "ppmv as carbon" was then converted to "ppmv as Stoddard solvent" by dividing by 7.05 (response factor determined by a contractor, Engineering Science, during emissions testing performed at Bldg 348 in Sep 92).[2] The molecular weight of Stoddard solvent (140) was then used with Equation 1 to convert "ppmv as Stoddard solvent" to a mass flow rate (lb/hr Stoddard solvent).

Example calculations, using Equations 1 and 2 above, are shown in Appendix I.

Opacity (visible emission) readings were recorded by a person who is certified by the Texas Natural Resources Conservation Commission. Three opacity runs were conducted. Each run consisted of taking readings every 15 seconds for 30 minutes. Due to a man-power shortage, each opacity run was conducted shortly before a stack sampling run. The incinerator was operated under the same conditions for the opacity runs and the corresponding stack sampling runs.

RESULTS

Sampling of the inlet duct gas stream was performed on 19-20 Jul 95 during normal test stand operations in Bldg 348. Although the SUE Incinerator was not operational at this time, permission to proceed with the inlet testing was given by the TNRCC. Table 1 provides a summary of the results from the inlet testing. The average VOC mass flow rate for the three sampling runs was 10.2 lb/hr as propane.

The SUE Incinerator became fully operational in early Jan 96. Sampling of the exhaust stack gas was therefore performed on 10-11 Jan 96 during normal test stand operations in Bldg 348. During testing, the incinerator was operated at approximately 70% capacity. The incinerator fuel combustion rate during all three

sampling runs was approximately 108 pounds per hour (lb/hr) of liquid waste calibration fluid and 4,000 standard cubic feet per hour (scfh) of natural gas. Table 2 provides a summary of the results from the exhaust testing. In brief, the average VOC mass emission rate for the three sampling runs was 0.66 lb/hr as propane, the average NO_x mass emission rate was 1.9 lb/hr as NO_2, and the average CO emission rate was 3.4 lb/hr. All visible emission readings showed 0 percent opacity.

Based on the VOC inlet and VOC exhaust mass emission rates and on the amount of liquid waste calibration fluid burned, the average VOC destruction efficiency was calculated to be 99.3 percent. A summary of the data used to calculate this destruction efficiency is found in Table 3.

DISCUSSION

Results show that the VOC, NO_x, and CO mass emission rates from the SUE Incinerator were all well below TNRCC Permit limits. With no opacity readings above 0 percent, the SUE Incinerator also met the TNRCC limit for opacity. Finally, the 99.3 percent destruction efficiency demonstrated by the SUE Incinerator was above the TNRCC minimum requirement of 98 percent.

RECOMMENDATIONS

The following recommendations are provided to ensure compliance with TNRCC Permit No. 6493 regarding the Bldg 348 test stands and the SUE Incinerator:

1. Ensure the temperature inside the incinerator is always maintained above 1450° F during operation.

2. Ensure the following records are maintained on base for a period of at least two years:

a. Records of the amount of calibration fluid purchased and of waste calibration fluid sent to reclamation.

b. Inventory records on the contents of the Calibration Fluid Supply Tank and the Waste Calibration Fluid Storage Tank.

c. Records of the quantity of calibration fluid (Stoddard solvent) or shelf life oil burned in the SUE Incinerator.

d. Records of the hours of operation of the SUE Incinerator.

Table 1. Inlet Duct Sampling Results

	Run 1	Run 2	Run 3	Average
Test Date	19 Jul 95	20 Jul 95	20 Jul 95	
Test Time (Military)	1256-1356	1042-1142	1327-1427	
Station Pressure ("Hg)	29.260	29.205	29.205	
Duct Static Pressure ("H_2O)	-1.46	-1.46	-1.46	
Avg Dry Bulb Temperature (°F)	82	80	84	
Avg Wet Bulb Temperature (°F)	70	70	70	
Gas Moisture Content (%H_2O)	2.1	2.2	2.0	
Gas Oxygen Content (%O_2)[1]	20.9	20.9	20.9	
Avg Velocity Pressure ("H_2O)	0.10	0.10	0.10	
Avg Gas Velocity (ft/sec)	18	18	18	
Actual Gas Flow Rate (ACFM)	10,858	10,901	10,847	10,869
Corrected Flow Rate (DSCFM)	10,094	10,132	10,028	10,085
Avg VOC Reading (ppmv)[2]	202	100	144	149
VOC Emission Rate (lb/hr)[3]	13.9	6.9	9.8	10.2

Units
"Hg = inches of mercury
"H_2O = inches of water
°F = degrees Fahrenheit
%H_2O = percent water
%O_2 = percent oxygen
ft/sec = feet per second
ACFM = actual cubic feet per minute
DSCFM = dry standard cubic feet per minute
ppmv = parts per million by volume
lb/hr = pounds per hour Note: lb/hr = (ppm) (MW) (DSCFM) (1.55×10^{-7})

Notes
[1] Based on ambient air
[2] Measured as propane
[3] Calculated as propane

Table 2. Exhaust Stack Sampling Results

	Run 1	Run 2	Run 3	Average
Test Date	10 Jan 96	11 Jan 96	11 Jan 96	
Test Start Time (Military)	1416	1155	1442	
Station Pressure ("Hg)	29.305	29.460	29.410	
Stack Static Pressure ("H_2O)	-0.20	-0.20	-0.20	
Average Stack Gas Temperature (°F)	606	632	629	622
Stack Gas Moisture Content (%H_2O)	2.9	1.7	2.1	2.2
Stack Gas Oxygen Content (%O_2)	18.8	18.7	18.8	18.8
Stack Gas Carbon Dioxide Content (%CO_2)	1.6	1.7	1.6	1.6
Stack Gas Velocity (ft/sec)	41	41	42	41
Actual Stack Gas Flow Rate (ACFM)	19,440	19,446	19,940	19,609
Corrected Flow Rate (DSCFM)	9,155	9,097	9,297	9,183
Average CO Reading (ppmv)	91	108	54	84
Average NO_x Reading (ppmv)	26	29	31	29
Average VOC Reading (ppmv as propane)	14.7	9.1	8.1	10.6
CO Emission Rate (lb/hr)	3.6	4.3	2.2	**3.4**
NO_x Emission Rate (lb/hr as NO_2)	1.7	1.9	2.1	**1.9**
VOC Emission Rate (lb/hr as propane)	0.92	0.56	0.51	**0.66**
Opacity (%)*	0	0	0	**0**

* Opacity readings were taken just prior to the stack gas sampling with the incinerator operating under the same conditions

<u>Units</u>
"Hg = inches of mercury
"H_2O = inches of water
°F = degrees Fahrenheit
%H_2O = percent moisture
%O_2 = percent oxygen
ft/sec = feet per second
ACFM = actual cubic feet per minute
DSCFM = dry standard cubic feet per minute
ppmv = parts per million by volume
lb/hr = pounds per hour   Note: lb/hr = (ppm) (MW) (DSCFM) (1.55×10^{-7})

<u>TNRCC Permit Limits</u>
CO: 21.80 lb/hr
NO_x: 7.69 lb/hr as NO_2
VOC: 5.53 lb/hr as propane
Opacity: 5%

Table 3. VOC Destruction Efficiency Data

	Run 1	Run 2	Run 3	Average
Corrected Stack Gas Flow Rate (DSCFM)	9,155	9,097	9,297	9,183
Measured Stack Gas VOC Concentration (ppmv as propane)	14.7	9.1	8.1	10.6
Converted Stack Gas VOC Concentration (ppmv as Stoddard solvent)	6.3	3.9	3.4	4.5
Converted Stack Gas VOC Emission Rate (lb/hr as Stoddard solvent)	1.25	0.77	0.69	0.90
Corrected Inlet Air Flow Rate (DSCFM)				10,085*
Measured Inlet Air Stream Solvent Vapor Concentration (ppmv as propane)				149*
Converted Inlet Air Stream Solvent Vapor Concentration (ppmv as Stoddard solvent)				63.4
Converted Inlet Air Stream Solvent Vapor Rate (lb/hr as Stoddard solvent)				13.9
Liquid Waste Solvent Consumption Rate (lb/hr Stoddard solvent)	108	107	108	107.7
Total Stoddard Solvent Consumption Rate (lb/hr)	121.9	120.9	121.9	121.6
VOC Destruction Efficiency (%)	99.0	99.4	99.4	**99.3**

* Determined from testing performed in Jul 95

Units
DSCFM = dry standard cubic feet per minute
ppmv = parts per million by volume
lb/hr = pounds per hour   Note: lb/hr = (ppm) (MW) (DSCFM) (1.55×10^{-7})

TNRCC Permit Requirement: VOC Destruction Efficiency $\geq$ 98%

e. Charts from the temperature monitor for the SUE Incinerator.

3. Ensure another VOC destruction efficiency determination is performed on the SUE Incinerator if the base decides to use waste shelf life oil as a supplemental fuel.

4. Ensure the VOC emissions from the 33 test stands vented directly to the atmosphere are calculated and tabulated monthly. The emission calculations shall be based on calibration fluid usage (i.e., mass-balance). The calculated emissions must also be reported in the annual base air emissions inventory.

Armstrong Laboratory will remain active in supporting the base's present and future needs.

REFERENCES

1. USAF Occupational and Environmental Health Laboratory, Volatile Organic Compound (VOC) Testing at Building 348, Kelly AFB TX, USAFOEHL Report 87-147EQ0094LEF, Brooks AFB TX, November 1987.

2. Engineering-Science, Inc., VOC Testing of the Carbon Adsorption Unit, Building 348, Kelly Air Force Base, Texas, Austin TX, April 1993

3. San Antonio Air Logistics Center, Vapor Incineration System Program, Kelly AFB TX, 12 June 1995

4. Texas Natural Resource Conservation Commission, Permit Number 6493, Austin TX, 24 March 1994

5. Office of the Federal Register National Archives and Records Service, Code of Federal Regulations, Title 40, Part 60, Washington DC, July 1994.

6. U.S. Environmental Protection Agency, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III. Stationary Sources Specific Methods, EPA/600/4-77/-07b, Research Triangle Park NC, December 1984

7. U.S. Environmental Protection Agency, Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators, EPA-340/1-85-018, Research Triangle Park NC, May 1987

APPENDIX A

Personnel Information

PERSONNEL INFORMATION

1. Armstrong Laboratory Air Quality Test Team

   Maj Larry Kimm, Chief, Air and Hazardous Waste Branch
   Capt Robert O'Brien, Air Quality Consultant, Project Officer
   Capt Gregory Durand, Air Quality Consultant
   Capt T.C. Moore, Air Quality Meteorologist
   2Lt Kyle Blasch, Air Quality Consultant
   MSgt Kurt Jagielski, Air Quality Technician
   SSgt Michael Dobbins, Air Quality Technician

   AL/OEBQ
   2402 E Drive
   Brooks AFB TX 78235-5114
   Phone: DSN 240-3305
   Comm (210) 536-3305

2. Kelly AFB On-Site Representatives

   Capt Michael Blank, Air Quality Program Manager
   SA-ALC/EMC
   307 Tinker Dr.(Bldg 306)
   Kelly AFB, TX 78241-5917
   Phone: DSN 945-3100 ext 306
   Comm (210) 925-3100 ext 306

   Mr Robert Burns, Mechanical Engineer
   SA-ALC/LPPEC
   505 Perrin Road (Bldg 324)
   Kelly AFB, TX 78241-6435
   Phone: DSN 945-8655
   Comm (210) 925-8655

   Mr John Jurek, Mechanical Engineer
   SA-ALC/LPPEC
   505 Perrin Road (Bldg 324)
   Kelly AFB, TX 78241-6435
   Phone: DSN 945-7581
   Comm (210) 925-7581

3. Kaiser Marquardt On-Site Representative

   Mr Ray Wieveg, Design Engineer
   Kaiser Marquardt
   16555 Saticoy Street
   Van Nuys, CA 91406-1739
   Phone: (818) 989-6542

APPENDIX B

Calibration Fluid Information

MIL-C-7024D Calibrating Fluids, Aircraft Fuel System Components

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Rev D: 30 Aug 1990
FSCM (CAGE): 81349
NSN: 6850-00-656-0810

Classification: Type II Special Run
Stoddard Solvent CH4*B6, M.W. = 140

Chemical Family: Paraffinic and Naphthenic Hydrocarbons

------------- VSMF -------------
Locator Code: H-24-15
Film Loc: X552-1268
Microfiche: 011268 Loc: 0163D06

Synonyms: Stoddard Solvent, Mineral Spirits, Short Range Mineral Spirits

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Specific Gravity: 0.770 ± 0.005 @ 60°F, 15.6°C	ASTM Test Method D1298
Viscosity: 1.17 ± 0.05 centistokes @ 77°F, 25°C	ASTM Test Method D445
Particulate Matter (min): 2.0 mg/liter	ASTM Test Method D2276
Flash Point (min): 100°F, 38°C	ASTM Test Method D56
Initial/Final Boiling Points: 300°F/410°F	ASTM Test Method D86
Aromatics, Volume Percent (max): 20.0%	ASTM Test Method D1319
Olefins, Volume Percent (max): 5.0%	ASTM Test Method D1319
Total Acid Number (max): 0.015 mg KOH/g	ASTM Test Method D3242
Gum, Existent (max): 5.0 mg/100 ml	ASTM Test Method D381
Vapor Pressure: 0.1 psi @ 100°F	ASTM Test Method D323

Autoignition Temperature: >400°F   Percent Volatile: essentially 100%
Flammability Limits in Air:
Lower Explosive Limit: 0.9%   Upper Explosive Limit: 6.0%
Vapor Density (air=1): <1.0
Solubility in Water: Negligible   Water Weight: 8.33 lbs/gal at 80°F
Appearance and Odor: Water white liquid with mild hydrocarbon odor
NFPA Classification:
Health: Slightly Hazardous (1)   Fire: Moderate (2)
Reactivity: Stable (0)   Specific Hazard: not applicable
Weight: 6.47 lbs/gal at 60°F and 6.34 lbs/gal at 80°F

SUPPLIERS

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1. Solvents & Chemicals, Inc.
   4707 Shank Road, P.O. Box 490
   Pearland, Texas 77588-0490
   Tel: (713) 485-5377

2. Southwest Solvents & Chemicals
   225 Two Twenty-One Drive
   Buda, Texas 78610
   Tel: (512) 282-6390

FUELS COMPARISON

FUEL	FLASHPOINT (°F)	SPEC GRAVITY (KG/L)	VISCOSITY (CENTISTOKES)
JP8 MIL-T-83133	100	0.775 min 0.840 max	8.0
JP5/JP8 ST MIL-T-5624N	140	0.815 min 0.845 max	8.5
JP5 MIL-F-5624	140	0.788 min 0.845 max	8.5
CAL FLUID MIL-C-7024D TYPE 2	100	0.765 min 0.775 max	3.3

APPENDIX C

Operating Permit

RECEIVED
SA-ALC/EM KELLY
94 MAR 28 PM 1:20

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

March 24, 1994

Mr. Lawrence O. Bailey, Jr.
Director, Environmental Management
KELLY AIR FORCE BASE (AFB)
307 Tinker Drive, Building 306
Kelly AFB, Texas 78241-5917

Re: Permit Amendment and Renewal
Permit No. 6493
Fuel Accessory Test Facility
Incinerator
Kelly AFB, Bexar County
Account ID No. BG-0108-F

Dear Mr. Bailey:

This is in response to your permit application, Form PI-1, and renewal application, Form PI-1R, concerning the proposed amendment and renewal of Permit No. 6493. We understand that you propose to replace the current carbon absorption unit with a thermal oxidizer that will achieve 95 percent destruction of the volatile organic compounds (VOC) routed through it.

Pursuant to Texas Natural Resource Conservation Commission (TNRCC) Rule 116.116(a) of 30 Texas Administrative Code §116 (30 TAC §116) (commonly known as Regulation VI), Permit No. 6493 is hereby amended in accordance with your proposal. This information will be incorporated into the existing permit file.

Also, pursuant to TNRCC Rule 116.314(a) of 30 TAC §116, your permit is hereby renewed. Enclosed are new provisions and an emission allowable table. Please attach these to your permit. We will appreciate your carefully reviewing the conditions of the permit and assuring that all requirements are consistently met.

We have enclosed two operations certification forms (Form PI-3A and Form PI-3B). Rule 116.110(b) of 30 TAC §116 (commonly known as Regulation VI) requires you to certify that operations addressed in this permit are in conformance with representations in the permit application.

Please file these certifications with both the TNRCC Austin New Source Review Program and the appropriate TNRCC regional office in a timely manner as prescribed by rule.

Thank you for your cooperation in sending us the information necessary to evaluate your operations and for your commitment to air pollution control. Please let us know if you have any questions.

Sincerely,

Jeffrey A. Saitas
for Anthony C. Grigsby
Executive Director

Enclosures

cc: Mr. James Menke, Air Program Manager, San Antonio
Mr. Sam Sanchez, Chief Sanitarian, Division of Environmental Services, San Antonio Metropolitan Health District, City of San Antonio

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Office of Air Quality
New Source Review Program
Post Office Box 13087
Austin, Texas 78711-3087

TNRCC

A

FORM PI-3A

Operations Certification (Part 1 of 2)
TNRCC Rule 116.110(b)(1)(A)

For facilities permitted by authority of Title 30 Texas Administrative Code, Chapter 116.

This certification must be signed by an individual with process knowledge in a managerial capacity and must be submitted upon completion of construction and prior to start of operation of the authorized facilities.

Permit Number________________
Date of Permit Issuance or Last Amendment:__________________

I. Permittee

Permit Issued To:____
Mailing Address:____
____
Technical Contact: (Person, Title, Mailing Address)____________________
____ Telephone:( )_____-_______

II. Permit Unit Information

Permit Unit Name:____
Location: Nearest City____________________ County:__________________
TNRCC Air Quality Account Number: ____-________-__

III. Construction and Operating Schedule Dates

Start of Construction:_________________ Proposed Start of Operation:____________
Completion of Construction: ____________

IV. A copy of this certification must be sent to the TNRCC Regional Office.

Regional Office (city) sent to: ___________________________________

V. Certification

I, ______________________________ ______________________________________

Name - please print or type Title - Owner, Plant Manager, President, Vice President, Environmental Director

state that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge. I certify that the facilities or changes authorized by the referenced permit have been accomplished as represented, if those representations affect emissions, method of control, or character of emissions.

DATE___________ SIGNATURE______________________________________

Note: Original signature in ink required.

A second certification, FORM PI-3B, must be submitted simultaneously with any report of testing or monitoring results required by the permit or, if no testing or monitoring is required, within 60 days of the commencement of operation.

Version 11/01/1993

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Office of Air Quality
New Source Review Program
Post Office Box 13087
Austin, Texas 78711-3087

TNRCC

B

FORM PI-3B

Operations Certification (Part 2 of 2)
TNRCC Rule 116.110(b)(1)(B)

For facilities permitted by authority of Title 30 Texas Administrative Code, Chapter 116.

This certification must be signed by an individual with process knowledge in a managerial capacity, and must be submitted simultaneously with any report of testing or monitoring results required by the permit or, if no testing or monitoring is required, within 60 days of the commencement of operation.

Permit Number: ______________________________
Date of Permit Issuance or Last Amendment: ______________

Submittal Date of Form PI-3A (Part 1 of Operations Certification): ______________

I. Permittee

Permit Issued To: ______________________________
Mailing Address: ______________________________
____
Technical Contact: (Person, Title, Mailing Address) ______________________________
______________________________ Telephone:(   ) ____-______

II. Permit Unit Information

Permit Unit Name: ______________________________
Location: Nearest City: ______________ County: ______________
TNRCC Air Quality Account Number: ___-______-__

III. Construction and Operating Schedule Dates

Start of Construction: ______________ Start of Operation: ______________
Completion of Construction: ______________

IV. A copy of this certification must be sent to the TNRCC Regional Office.

Regional Office (city) sent to: ______________________________

V. Certification

I, ______________________________ ______________________________
Name - please print or type   Title - Owner, Plant Manager, President, Vice President, Environmental Director

state that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge. I certify that the facility complies with all terms of the preconstruction permit and that operations of the facility are in compliance with the Texas Clean Air Act (Chapter 382, Texas Health & Safety Code) and the air quality rules of the TNRCC.

DATE ____________ SIGNATURE ______________________________

Note: Original signature in ink required.

Version 11/01/1993

GENERAL PROVISIONS

6493

1. Equivalency of Methods - It shall be the responsibility of the holder of this permit to demonstrate or otherwise justify the equivalency of emission control methods, sampling or other emission testing methods and monitoring methods proposed as alternatives to methods indicated in the provisions of this permit. Alternative methods shall be applied for in writing and shall be reviewed and approved by the Executive Director prior to their use in fulfilling any requirements of this permit.

2. Sampling Requirements - If sampling of stacks or process vents is required, the holder of this permit must contact the Source and Mobile Monitoring Section of the Texas Natural Resource Conservation Commission (TNRCC) prior to sampling to obtain the proper data forms and procedures. The holder of this permit is also responsible for providing sampling facilities and conducting the sampling operations at his own expense.

3. Appeal - This permit may be appealed pursuant to Rule 103.81 of the Procedural Rules of the TNRCC and Section 382.032 of the Texas Clean Air Act. Failure to take such appeal constitutes acceptance by the applicant of all terms of the permit.

4. Construction Progress - Start of construction, construction interruptions exceeding 45 days and completion of construction shall be reported to the appropriate regional office of the TNRCC not later than 10 working days after occurrence of the event.

5. Recordkeeping - Information and data concerning production, operating hours, sampling and monitoring data, if applicable, fuel type and fuel sulfur content, if applicable, shall be maintained in a file at the plant site and made available at the request of personnel from the TNRCC or any local air pollution control program having jurisdiction. The file shall be retained for at least two years following the date that the information or data is obtained.

6. Maintenance of Emission Control - The facilities covered by this permit shall not be operated unless all air pollution emission capture equipment and abatement equipment are maintained in good working order and operating properly during normal facility operations.

SPECIAL PROVISIONS

6493

EMISSION STANDARDS, FUEL SPECIFICATIONS, AND WORK PRACTICES

1. This permit covers only those sources of emissions listed in the attached table entitled "Emission Sources - Maximum Allowable Emission Rates," and those sources are limited to the emission limits and other conditions specified in the attached table. The annual rates are based on any consecutive 12-month period.

2. Compliance with the Volatile Organic Compound (VOC) emission limitation for the SUE Incinerator (EPN No. 20) shall be demonstrated by monitoring the temperature of the secondary chamber. Compliance with the VOC emissions for test stands vented to the atmosphere will be demonstrated by calculating emissions from carbon compound usage. The emissions shall be tabulated monthly and reported annually with the facility emissions inventory.

3. All waste carbon compounds must be stored in closed containers.

4. Opacity of emissions from the SUE incinerator stack must not exceed 5 percent averaged over a six-minute period.

5. Fuel for the SUE incinerator shall be limited to stoddard solvent, shelf life hydrocarbon materials, and pipeline-quality natural gas containing no more than 0.25 grains hydrogen sulfide and 5.0 grains total sulfur per 100 dscf.

6. The minimum exhaust exit gas temperature of the SUE incinerator of 1450°F must be continuously monitored and recorded whenever burning VOCs, stoddard solvent, or shelf life oils.

7. A copy of this permit shall be kept at the plant site and made immediately available at the request of personnel from the Texas Natural Resource Conservation Commission (TNRCC), Environmental Protection Agency (EPA), or any local air pollution control agency having jurisdiction. In addition, the holder of this permit shall clearly identify all equipment at the facility covered by this permit that has the potential of emitting air contaminants. Permitted emission points shall be clearly identified corresponding to the emission point numbering on the maximum allowable emission rates table. Grandfathered or exempt facilities shall be clearly identified corresponding to the emission point numbering used in the most recent emissions inventory submitted to the TNRCC.

INITIAL DETERMINATION OF COMPLIANCE

8. The holder of this permit shall perform stack sampling and other testing as required to establish the actual pattern and quantities of air contaminants being emitted into the atmosphere from the SUE incinerator stack. The holder of this permit is responsible for providing sampling and testing facilities and conducting the sampling and testing operations at his expense.

   A. The appropriate TNRCC regional office in the region where the source is located shall be contacted as soon as testing is scheduled but not less than 45 days prior to sampling to schedule a pretest meeting. The notice shall include:

      (1) Date for pretest meeting.
      (2) Date sampling will occur.
      (3) Name of firm conducting sampling.
      (4) Type of sampling equipment to be used.
      (5) Method or procedure to be used in sampling.

   The purpose of the pretest meeting is to review the necessary sampling and testing procedures, to provide the proper data forms for recording pertinent data, and to review the format procedures for submitting the test reports.

   A written proposed description of any deviation from sampling procedures specified in permit provision or TNRCC or EPA sampling procedures shall be made available to the TNRCC prior to the pretest meeting. The Regional Manager or the Manager of the Source and Mobil Monitoring Section shall approve or disapprove of any deviation from specified sampling procedures.

   Requests to waive testing for any pollutant specified in B of this provision shall be submitted to the TNRCC New Source Review Program.

   B. Air contaminants emitted from the incinerator stack to be tested for include (but are not limited to) VOC, nitrogen oxides (NOx), and carbon monoxide (CO).

   C. If sampling ports and platforms meeting the specifications set forth in the attachment entitled "Chapter 2, Stack Sampling Facilities" are not required, alternate designs may be approved at the pretest meeting.

D. Sampling shall occur within 60 days after initial start-up of the SUE incinerator. Requests for additional time to perform sampling shall be submitted to the regional office.

E. The VOC destruction efficiency of 98 percent for the SUE incinerator while burning stoddard solvent and shelf life oils shall be demonstrated at the maximum test stand VOC generation rate during stack emission testing. Primary operating parameters that enable determination of VOC generation rate shall be monitored and recorded during the stack test. These parameters will be determined at the pretest meeting.

F. Copies of the final sampling report shall be forwarded to the TNRCC within 90 days after sampling is completed. Sampling reports shall comply with the attached provisions of Chapter 14 of the TNRCC Sampling Procedures Manual. The reports shall be distributed as follows:

One copy to the appropriate TNRCC regional office.
One copy to the TNRCC New Source Review Program, Austin.

G. At least two 6-minute visual opacity readings will be taken during the testing.

CONTINUOUS DEMONSTRATION OF COMPLIANCE

9. Temperature in the SUE incinerator must be continuously monitored and recorded to ensure the minimum temperature of 1450°F is maintained.

RECORDKEEPING REQUIREMENTS

10. The following records shall be maintained by the source for a period of two years and shall be made available to the Executive Director or his designated representative upon request:

A. Records of the amount of calibrating fluid purchased and spent calibrating fluid sent to reclamation.

B. Inventory records on the contents of the Calibrating Fluid Supply Tank and the Spent Calibrating Fluid Storage Tank.

C. Records of the quantity of stoddard solvent and shelf life oil burned in the SUE incinerator.

D. Records of hours of operation of the SUE incinerator.

E. Charts from the temperature monitor for the SUE incinerator.

F. Inventory records of additions, recovery, and disposal of all degreasing solvents and cleaning solvents.

G. Records of inspection and replacement of bags in the grit blast filter system.

Dated 3/24/94

EMISSION SOURCES - MAXIMUM ALLOWABLE EMISSION RATES

6493

This table lists the maximum allowable emission rates and all sources of air contaminants on the applicant's property covered by this permit. The emission rates shown are those derived from information submitted as part of the application for permit and are the maximum rates allowed for these facilities. Any proposed increase in emission rates may require an application for a modification of the facilities covered by this permit.

AIR CONTAMINANTS DATA

Emission Point No. (1)	Source Name (2)	Air Contaminant Name (3)	Emission Rates* #/hr	TPY
7	Vapor Degreaser	VOC	0.80	2.50
8	Drying Oven	VOC	1.81	5.65
9	Vapor Blasting	PM/PM10 VOC	0.46 0.10	1.44 0.31
10	Abrasive Blasting	PM/PM10	0.03	0.09
11	3 Test Stands	VOC	0.12	0.37
12	3 Test Stands	VOC	0.12	0.37
13	2 Test Stands	VOC	0.05	0.16
14	5 Test Stands	VOC	0.79	2.46
15	4 Test Stands	VOC	0.08	0.25
16	Abrasive Blasting	PM/PM10	0.03	0.09
17	2 Test Stands	VOC	0.21	0.66
18	2 Test Stands	VOC	0.20	0.62
19	Nitric Acid Tank	HNO3	0.05	0.16
20	Sue Incinerator 20,000 SCFM	VOC NOx CO	5.53 7.69 21.80	24.20 33.70 95.00
21	3 Test Stands	VOC	0.12	0.37
22	3 Test Stands	VOC	0.12	0.37
23	3 Test Stands	VOC	0.12	0.37

APPENDIX D

Field Data

PRELIMINARY SURVEY DATA SHEET NO. 2

(Velocity and Temperature Traverse)

BASE: Kelly AFB	DATE: 19 Jul 75
~~BOILER NUMBER~~ Source: Inlet Duct to Fuel Accessory Shop's SUE Incinerator (Run #1)	
INSIDE STACK ~~DIAMETER~~ Area: 5' by 2' = 10 Ft^2	~~Inches~~
STATION PRESSURE: 29.260	In Hg
STACK STATIC PRESSURE: -1.46	In H20
SAMPLING TEAM: AL/OEBQ	

TRAVERSE POINT NUMBER	VELOCITY HEAD, Vp IN H20	$\sqrt{V_p}$	STACK TEMPERATURE (°F) Dry Bulb	Wet Bulb
1	0.050		87	72
2	0.080		85	69
3	0.078		83	69
4	0.040		85	69
5	0.080		85	70
6	0.102		78	68
7	0.105		77	67
8	0.100		83	69
9	0.102		77	69
10	0.115		83	73
11	0.100		78	69
12	0.100		83	69
13	0.150		82	70
14	0.130		80	69
15	0.139		81	70
16	0.141		82	71
	Avg ΔP = 0.10	Avg =	82	70
Avg FPS = 18				
Avg FPM = 1,086	ACFM =	10,858	% H_2O = 2.1	
	DSCFM =	10,094		
	AVERAGE			

PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE: Kelly AFB	DATE: 20 Jul 95
BOILER NUMBER: Inlet Duct to Fuel Accessory Shop's SWE Incinerator (Run # 2)	
INSIDE STACK ~~DIAMETER~~ Area: 5' by 2' = 10 ft²	~~Inches~~
STATION PRESSURE: 29.205	In Hg
STACK STATIC PRESSURE: -1.46	In H20
SAMPLING TEAM: AL/OEBQ	

TRAVERSE POINT NUMBER	VELOCITY HEAD, Vp IN H20	$\sqrt{V_p}$	STACK TEMPERATURE (°F) Dry Bulb	Wet Bulb
1	0.045		81°	72°
2	0.065		79°	69°
3	0.075		79°	69°
4	0.025		79°	70°
5	0.100		83°	71°
6	0.115		79°	70°
7	0.110		79°	70°
8	0.090		79°	69°
9	0.115		81°	70°
10	0.105		80°	70°
11	0.110		80°	69°
12	0.090		80°	69°
13	0.175		84°	71°
14	0.135		82°	70°
15	0.140		80°	69°
16	0.155		80°	69°
	Avg ΔP = 0.10	Avg =	80	70
Avg FPS = 18	ACFM =	10,901	% H_2O = 2.2	
Avg FPM = 1,090	DSCFM =	10,132		
	AVERAGE			

OEHL FORM 16 APR 78

PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE: KELLY AFB	DATE: 20 JUL 95

BOILER NUMBER: Inlet Duct to Fuel Accessory Shop's SUE Incinerator (Run #3)

INSIDE STACK ~~DIAMETER~~ AREA: 5' by 2' = 10 ft^2 ~~Inches~~

STATION PRESSURE: 29.205 In Hg

STACK STATIC PRESSURE: -1.46 In H20

SAMPLING TEAM: AL/OEBQ

TRAVERSE POINT NUMBER	VELOCITY HEAD, Vp IN H20	$\sqrt{V_p}$	STACK TEMPERATURE (°F) DRY BULB	WET BULB
1	0.030		86°	72°
2	0.055		83°	69°
3	0.055		85°	71°
4	0.040		82°	69°
5	0.110		89°	70°
6	0.115		84°	69°
7	0.105		83°	69°
8	0.095		84°	70°
9	0.090		85°	70°
10	0.120		84°	69°
11	0.115		84°	69°
12	0.095		84°	69°
13	0.135		82°	70°
14	0.145		84°	69°
15	0.165		84°	69°
16	0.160		86°	69°
	Avg ΔP = 0.10	Avg =	84	70
Avg FPS = 18				
Avg FPM = 1,085	ACFM =	10,841	% H_2O = 2.0	
	DSCFM =	10,028		
	AVERAGE			

OEHL FORM APR 78 16

VOC Emissions Data Sheet

Base: Kelly AFB	Date: 19 Jul 95
Source: Inlet duct to Fuel Accessory Shop's SUE Incinerator	Run #: 1

Calibration Data: (Note - meter readings must be within ± 5% of actual gas concentrations)

	Gas Concentration (ppm)	Meter Reading (ppm)	Mil Time
High Span:	803	803	1241
Medium Span:	506	500	1244
Low Span:	251	250	1247

Sampling Data:

STD ~~Military~~ Time	Reading (ppm)		STD ~~Military~~ Time	Reading (ppm)
12:56	182		1:30 pm	192
12:57	185		1:31 pm	191
12:58	193		1:32 pm	209
12:59 AM	198		1:33 pm	214
1:00 pM	192		1:34	218
1:01	222		1:35	219
1:02	208		1:36	215
1:03	224		1:37	213
1:04	224		1:38	209
1:05	214		1:39	199
1:06	212		1:40	196
1:07	218		1:41	194
1:08	237		1:42	190
1:09	228		1:43	186
1:10	228		1:44	186
1:11	240		1:45	189
1:12	237		1:46	183
1:13	238		1:47	182
1:14	231		1:48	183
1:15	230		1:49	180
1:16	226		1:50	177
1:17	220		1:51	172
1:18	218		1:52	173
1:19	211		1:53	171
1:20	212		1:54	166
1:21	206		1:55	171
1:22	204		1:56	167
1:23	201			
1:24	199			
1:25	195			
1:26	193			
1:27	193			
1:28	192			
1:29	191		Average Reading (ppm) =	202

240ppm = ~~.053~~ .024 % = .024 %

VOC Emissions Data Sheet			
Base: Kelly AFB		Date: 20 Jul 95	
Source: Inlet Duct to Fuel Accesory Shop's SUE Incinerator		Run #: 2	

Calibration Data: (Note - meter readings must be within ± 5% of actual gas concentrations)

	Gas Concentration (ppm)	Meter Reading (ppm)	Time
High Span:	803	803	1006
Medium Span:	506	501	1008
Low Span:	251	251	1010

Sampling Data:

Time	Reading (ppm)		Time	Reading (ppm)
1042	112		1116	88
1043	111		1117	87
1044	109		1118	87
1045	111		1119	84
1046	110		1120	84
1047	110		1121	87
1048	108		1122	94
1049	106		1123	94
1050	105		1124	94
1051	104		1125	98
1052	104		1126	94
1053	103		1127	95
1054	102		1128	98
1055	100		1129	101
1056	99		1130	120
1057	98		1131	117
1058	96		1132	116
1059	95		1133	118
1100	97		1134	116
1101	97		1135	112
1102	95		1136	114
1103	94		1137	112
1104	95		1138	115
1105	93		1139	110
1106	94		1140	110
1107	92		1141	108
1108	90		1142	113
1109	91			
1110	92			
1111	90			
1112	90			
1113	91			
1114	89			
1115	88	Average Reading (ppm) =		100

VOC Emissions Data Sheet

Base: Kelly AFB	Date: 20 Jul 95
Source: Inlet Duct to Fuel Accessory Shop's SHE Incinerator	Run #: 3

Calibration Data: (Note - meter readings must be within ± 5% of actual gas concentrations)

	Gas Concentration (ppm)	Meter Reading (ppm)	Time
High Span:	803	803	1309
Medium Span:	506	500	1311
Low Span:	251	251	1313

Sampling Data:

Time	Reading (ppm)		Time	Reading (ppm)
1327	135		1401	132
1328	135		1402	133
1329	136		1403	132
1330	148		1404	131
1331	144		1405	129
1332	147		1406	128
1333	148		1407	129
1334	152		1408	150
1335	155		1409	158
1336	170		1410	151
1337	167		1411	149
1338	165		1412	156
1339	163		1413	150
1340	162		1414	145
1341	160		1415	142
1342	156		1416	140
1343	155		1417	136
1344	152		1418	135
1345	153		1419	134
1346	150		1420	132
1347	148		1421	130
1348	145		1422	130
1349	144		1423	127
1350	143		1424	139
1351	148		1425	136
1352	153		1426	134
1353	149		1427	131
1354	147			
1355	144			
1356	140			
1357	138			
1358	139			
1359	134			
1400	133		Average Reading (ppm) =	144

PRELIMINARY SURVEY DATA SHEET NO. 1
(Stack Geometry)

BASE Kelly AFB	PLANT Bld 348
DATE 29 Aug 95	SAMPLING TEAM
SOURCE TYPE AND MAKE SUE Incinerator	
SOURCE NUMBER	INSIDE STACK DIAMETER Inches
RELATED CAPACITY	TYPE FUEL Natural Gas
DISTANCE FROM OUTSIDE OF NIPPLE TO INSIDE DIAMETER 24.75 Inches	
NUMBER OF TRAVERSES 4	NUMBER OF POINTS/TRAVERSE 7, 5, 3, and 1 respectively

LOCATION OF SAMPLING POINTS ALONG TRAVERSE

POINT	PERCENT OF DIAMETER	DISTANCE FROM INSIDE WALL *(Inches)*	TOTAL DISTANCE FROM OUTSIDE OF NIPPLE TO SAMPLING POINT *(Inches)*
1		4"	28.75
2		10"	34.75
3		16"	40.75
4		22"	46.75
5		28"	52.75
6		34"	58.75
7		40"	64.75

OEHL FORM APR 78 15

PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE	DATE	
Kelly AFB	8 Jan 95	Start time 1444

BOILER NUMBER
SUE Incinerator Bldg 348

INSIDE STACK DIAMETER
Triangular stack with Effective Diameter of 28.05 Inches, Area of 8 ft

STATION PRESSURE
29.615 In Hg

STACK STATIC PRESSURE
-0.20 In H20

SAMPLING TEAM

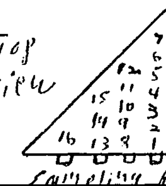
TRAVERSE POINT NUMBER	VELOCITY HEAD, Vp IN H20	~~$\sqrt{Vp}$~~ cyclonic angle	STACK TEMPERATURE (°F)
1	0.301	17	620
2	0.317	17	626
3	0.265	14	627
4	0.215	15	626
5	0.155	7	625
6	0.115	3	619
7	0.100	0	616
8	0.418	24	619
9	0.308	19	622
10	0.180	12	620
11	0.140	9	617
12	0.135	9	614
13	0.430	14	606
14	0.350	8	616
15	0.230	0	617
16	0.360	0	597
	AVERAGE 57		

OEHL FORM APR 78 16

Particulate Sampling Data Sheet

Date: 10 Jan 96	Nozzle Diameter: 0.347 in	Pre Pitot Check: ok	**Schematic of Stack**
Base: Kelly	Pitot Coefficient, C_p: 0.84	Post Pitot Check: ok	
Source ID: SWE Incinerator	Meter Box Y_i: 1.022	Pre Train Check: ok (at 15 "Hg)	
Run Number: 1	Meter Box $\Delta H@$: 1.944	Post Train Check: ok (at 3 "Hg)	
Station Pressure: 29.305 "Hg	Meter Box #: 6	Assumptions	
Static Pressure: -0.2 "H_2O	Probe #: 6-1	%H_2O: 8 MW$_D$: 29	

Top View



#'s refer to sampling points

sampling ports

Traverse Point Number	Sampling Time (min)	Dry Gas Meter Vol (ft^3)	Gas Meter Temp, T_m In (°F)	Gas Meter Temp, T_m Out (°F)	Stack Temp, T_s (°F)	Velocity Head, Δp ("H_2O)	Orifice Diff Press, ΔH ("H_2O)	Probe Temp (°F)	Sample Box Temp (°F)	Impinger Outlet Temp (°F)	Vacuum Pressure ("Hg)
	0	188.053									
1	3.75		73	74	603	0.355	1.7	239	245	Thermo-	2.5
2	7.50		78	74	609	0.550	1.7	240	240	couple	2.5
3	11.25		81	75	610	0.260	1.7	241	242	not	2.5
4	15.00		83	76	611	0.210	1.7	241	242	working	2.5
5	18.75		86	77	609	0.175	1.7	242	243		2.5
6	22.50		89	78	605	0.145	1.7	243	241		2.5
7	26.25		89	78	602	0.115	1.7	244	244		2.6
8	30.00		88	78	609	0.412	1.7	241	242		2.5
9	33.75		89	79	610	0.275	1.7	241	242		2.5
10	37.50		90	79	611	0.151	1.7	241	242		2.5
11	41.25		91	80	611	0.128	1.7	242	242		2.5
12	45.00		92	80	611	0.160	1.7	242	241		2.5
13	48.75		89	80	600	0.461	1.7	241	243		2.5
14	52.50		91	81	607	0.360	1.7	242	241		2.5
15	56.25		92	81	608	0.225	1.7	242	242		2.5
16	60.00		90	82	577	0.430	1.7	242	241		2.5
		230.135								Impingers	
										kept	
										well	
										iced	

Total Gas Vol = 42.082 Avg T_m = 83 Avg T_s = 606 Avg ΔH = Avg $(P_sT_s)^{0.5}$ =

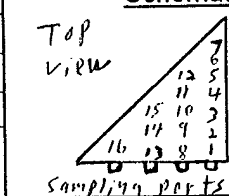
Nov 95

Meter Box Operator: R. O'Brien Signature: Robert O'Brien

Particulate Sampling Data Sheet

Date: 11 Jan 96	Nozzle Diameter: 0.347 in	Pre Pitot Check: ok	Schematic of Stack
Base: Kelly AFB	Pitot Coefficient, C_p: 0.84	Post Pitot Check: ok	
Source ID: SUE Incinerator	Meter Box Y_i: 1.022	Pre Train Check: ok (at 15 "Hg)	
Run Number: 2	Meter Box $\Delta H@$: 1.944	Post Train Check: ok (at 6 "Hg)	
Station Pressure: 29.460 "Hg	Meter Box #: 6	Assumptions	
Static Pressure: -0.20 "H_2O	Probe #: 6-1	%H_2O: MW$_D$:	

Top view



#'s refer to sampling points

Traverse Point Number	Sampling Time (min)	Dry Gas Meter Vol (ft^3) start 1155	Gas Meter Temp, T_m In (°F)	Gas Meter Temp, T_m Out (°F)	Stack Temp, T_s (°F)	Velocity Head, Δp ("H_2O)	Orifice Diff Press, ΔH ("H_2O)	Probe Temp (°F)	Sample Box Temp (°F)	Impinger Outlet Temp (°F)	Vacuum Pressure ("Hg)
	0	230.550									
1	3.75		72	72	630	0.340	1.7	241	242	52	5.1
2	7.50		75	73	632	0.350	1.7	240	241	46	4.7
3	11.25		78	74	641	0.285	1.7	241	242	48	2.5
4	15.00		81	75	638	0.225	1.7	242	243	50	2.5
5	18.75		84	76	636	0.185	1.7	242	242	51	2.5
6	22.50		87	77	638	0.135	1.7	243	243	51	2.5
7	26.25		89	79	632	0.113	1.7	243	243	53	2.6
8	30.00		89	81	633	0.416	1.7	243	246	54	2.8
9	33.75		92	82	638	0.285	1.7	243	244	52	2.8
10	37.50		94	83	636	0.144	1.7	244	244	52	2.7
11	41.25		95	85	636	0.120	1.7	244	245	52	2.6
12	45.00		97	86	638	0.155	1.7	244	243	52	2.6
13	48.75		95	87	608	0.410	1.7	244	244	55	2.7
14	52.50		98	88	632	0.348	1.7	243	243	50	2.7
15	56.25		100	89	631	0.210	1.7	243	242	51	2.7
16	60.00		99	90	610	0.436	1.7	243	243	54	2.6
		272.873									

Total Gas Vol = 42.323 Avg T_m = 85 Avg T_s = 632 Avg ΔH = Avg $(P_sT_s)^{0.5}$ =

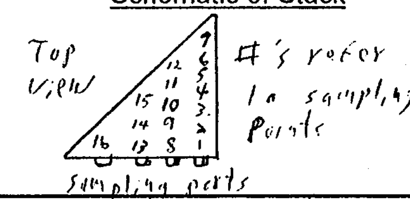
Nov 95

Meter Box Operator: R. O'Brien Signature: Robert O'Brien

Samack 1/11/96

Particulate Sampling Data Sheet

Date: 11 Jan 96	Nozzle Diameter: 0.347 in	Pre Pitot Check: ok	Schematic of Stack
Base: Kelly AFB	Pitot Coefficient, C_p: 0.84	Post Pitot Check: ok	
Source ID: SWE Incinerator	Meter Box Y_i: 1.022	Pre Train Check: ok (at 15 "Hg)	
Run Number: 3	Meter Box $\Delta H@$: 1.944	Post Train Check: ok (at 4 "Hg)	
Station Pressure: 29.410 "Hg	Meter Box #: 6	Assumptions	
Static Pressure: -0.20 "H_2O	Probe #: 6-1	%H_2O: MW$_D$:	



Traverse Point Number	Sampling Time (min)	Dry Gas Meter Vol (ft^3) start 1442	Gas Meter Temp, T_m In (°F)	Gas Meter Temp, T_m Out (°F)	Stack Temp, T_s (°F)	Velocity Head, Δp ("H_2O)	Orifice Diff Press, ΔH ("H_2O)	Probe Temp (°F)	Sample Box Temp (°F)	Impinger Outlet Temp (°F)	Vacuum Pressure ("Hg)
	0	273.327									
1	3.75		79	78	633	0.340	1.7	241	245	58	2.4
2	7.50		84	79	639	0.355	1.7	241	242	51	2.4
3	11.25		86	79	638	0.270	1.7	242	244	53	2.4
4	15.00		88	79	641	0.240	1.7	242	242	54	2.5
5	18.75		89	79	640	0.195	1.7	242	242	55	2.5
6	22.50		90	80	634	0.150	1.7	240	243	56	2.5
7	26.25		91	80	630	0.125	1.7	233	243	56	2.5
8	30.00		87	80	631	0.415	1.7	240	244	57	2.5
9	33.75		89	80	633	0.280	1.7	243	241	53	2.5
10	37.50		90	80	635	0.178	1.7	242	243	52	2.5
11	41.25		91	80	635	0.132	1.7	243	242	52	2.5
12	45.00		91	80	635	0.170	1.7	242	242	52	2.5
13	48.75		88	80	619	0.445	1.7	242	242	53	3.3
14	52.50		90	80	635	0.368	1.7	242	242	51	3.1
15	56.25		90	80	633	0.250	1.7	243	241	51	3.1
16	60.00		87	80	557	0.419	1.7	241	242	56	2.5
		315.755									

Total Gas Vol = 42.428 Avg T_m = 84 Avg T_s = 629 Avg ΔH = Avg $(P_s T_s)^{0.5}$ =

Nov 95

Meter Box Operator: R. O'Brien Signature: Robert O'Brien

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Kelly AFB	10 Jan 76	1

BUILDING NUMBER	SOURCE NUMBER
348	54E Incinerator

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER			
ACETONE WASHINGS *(Probe, Front Half Filter)*			
BACK HALF *(if needed)*			
	Total Weight of Particulates Collected		gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	216	200	16
IMPINGER 2 *(H20)*	204	200	4
IMPINGER 3 *(Dry)*	0	0	0
IMPINGER 4 *(Silica Gel)*	206 gm	200	6
	Total Weight of Water Collected		26 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2					
VOL % O_2					
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

OEHL FORM MAY 78 20

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Kelly AFB	11 Jan 96	2

BUILDING NUMBER	SOURCE NUMBER
348	SUE Incinerator

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER			
ACETONE WASHINGS *(Probe, Front Half Filter)*			
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	207	200	7
IMPINGER 2 *(H20)*	200	200	0
IMPINGER 3 *(Dry)*	0	0	0
IMPINGER 4 *(Silica Gel)*	208	200	8
	Total Weight of Water Collected		15 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2					
VOL % O_2					
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

OEHL FORM MAY 78 20

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Kelly AFB	11 Jan 96	3

BUILDING NUMBER	SOURCE NUMBER
348	SUE Incinerator

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER			
ACETONE WASHINGS *(Probe, Front Half Filter)*			
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	212	200	12
IMPINGER 2 *(H20)*	200	200	0
IMPINGER 3 *(Dry)*	0	0	0
IMPINGER 4 *(Silica Gel)*	207	200	7
	Total Weight of Water Collected		19 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2					
VOL % O_2					
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

OEHL FORM MAY 78 20

VISIBLE EMISSION OBSERVATION FORM

SOURCE NAME: Fuels · Accessories Repair & Test Facility Incinerator

ADDRESS:

CITY: Kelly AFB | **STATE:** TX | **ZIP:**

PHONE: | **SOURCE ID NUMBER:**

PROCESS EQUIPMENT: Thermal Oxidizer | **OPERATING MODE:** 70%

CONTROL EQUIPMENT: Allen Bradley PLC-5 | **OPERATING MODE:** automatic

DESCRIBE EMISSION POINT: tan brick stack located within the walled/fenced area on the north side of bldg 348 (FART Building)

HEIGHT ABOVE GROUND LEVEL: 30' | **HEIGHT RELATIVE TO OBSERVER:** 30'

DISTANCE FROM OBSERVER: 250' | **DIRECTION FROM OBSERVER:** 320°

DESCRIBE EMISSIONS: plume shape not visually detectable

EMISSION COLOR: Clear | **PLUME TYPE:** CONTINUOUS ☒ FUGITIVE ☐ INTERMITTENT ☐

WATER DROPLETS PRESENT: NO ☒ YES ☐ | **IS WATER DROPLET PLUME:** ATTACHED ☐ DETACHED ☐

AT WHAT POINT IN THE PLUME WAS OPACITY DETERMINED: just above stack tip

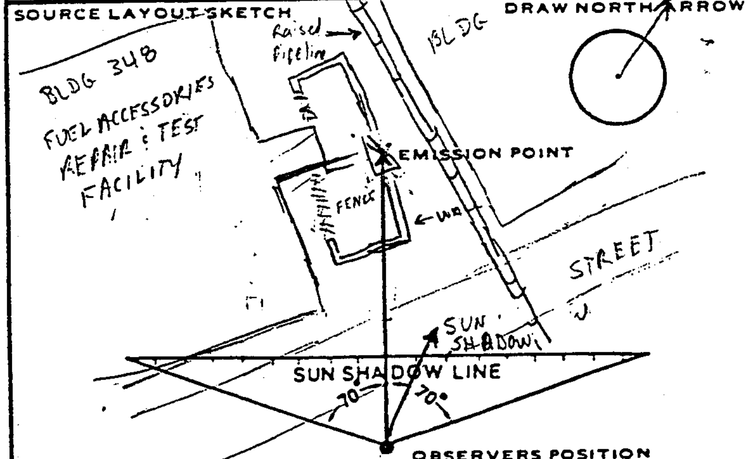
DESCRIBE BACKGROUND: blue sky with scattered white cirrus clouds

BACKGROUND COLOR: Blue | **SKY CONDITIONS:** mostly clear (scattered high cirrus clouds)

WIND SPEED: 5 KTS | **WIND DIRECTION:** E 150°

AMBIENT TEMPERATURE: 64° F | **RELATIVE HUMIDITY:** 62%

SOURCE LAYOUT SKETCH — DRAW NORTH ARROW



COMMENTS:

OBSERVATION DATE: 10 JAN 96 | **START TIME:** 1200 CST | **STOP TIME:** 1230 CST

M \ sec	0	15	30	45	M \ sec	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7	0	0	0	0	37				
8	0	0	0	0	38				
9	0	0	0	0	39				
10	0	0	0	0	40				
11	0	0	0	0	41				
12	0	0	0	0	42				
13	0	0	0	0	43				
14	0	0	0	0	44				
15	0	0	0	0	45				
16	0	0	0	0	46				
17	0	0	0	0	47				
18	0	0	0	0	48				
19	0	0	0	0	49				
20	0	0	0	0	50				
21	0	0	0	0	51				
22	0	0	0	0	52				
23	0	0	0	0	53				
24	0	0	0	0	54				
25	0	0	0	0	55				
26	0	0	0	0	56				
27	0	0	0	0	57				
28	0	0	0	0	58				
29	0	0	0	0	59				
30	0	0	0	0	60				

AVERAGE OPACITY FOR HIGHEST PERIOD: 0 | **NUMBER OF READINGS ABOVE % WERE:**

RANGE OF OPACITY READINGS: 0 MINIMUM 0 MAXIMUM

OBSERVER'S NAME (PRINT): THOMAS C. MOORE

OBSERVER'S SIGNATURE: Thomas C. Moore | **DATE:** 10 Jan 96

ORGANIZATION: U.S. Air Force (AL/OEBQ)

CERTIFIED BY: Philip J. Clark (TNRCC) | **DATE:** 15 Sep 95

VERIFIED BY: | **DATE:**

I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS

SIGNATURE:

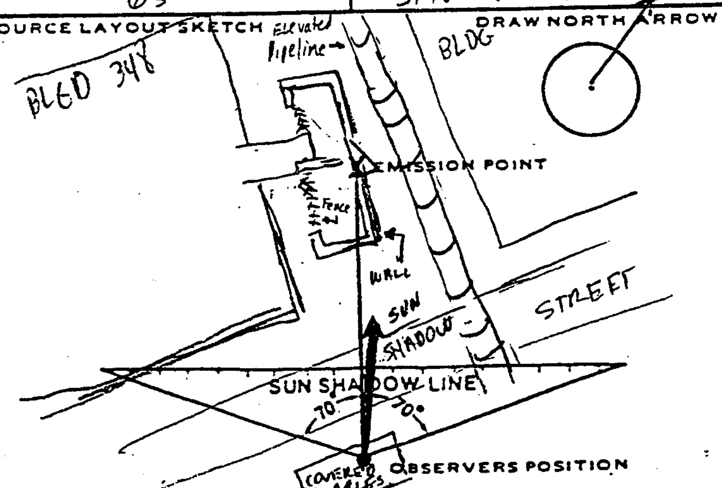
TITLE: | **DATE:**

VISIBLE EMISSION OBSERVATION FORM

SOURCE NAME	USAF Fuel Accessories Repair & Test Facility Incinerator
ADDRESS	
CITY	Kelly AFB
STATE	TX
ZIP	
PHONE	
SOURCE ID NUMBER	
PROCESS EQUIPMENT	Thermal Oxidizer
OPERATING MODE	70%
CONTROL EQUIPMENT	Allen Bradley PLC-5
OPERATING MODE	Automatic
DESCRIBE EMISSION POINT	(square stack with triangular inside) tan brick incinerator stack located in fenced/walled area on north side of bldg 348
HEIGHT ABOVE GROUND LEVEL	30'
HEIGHT RELATIVE TO OBSERVER	30'
DISTANCE FROM OBSERVER	250'
DIRECTION FROM OBSERVER	320°
DESCRIBE EMISSIONS	emission/plume characteristics not visually detectable
EMISSION COLOR	clear
PLUME TYPE	CONTINUOUS ☒ FUGITIVE ☐ INTERMITTENT ☐
WATER DROPLETS PRESENT	NO ☒ YES ☐
IS WATER DROPLET PLUME	ATTACHED ☐ DETACHED ☐
AT WHAT POINT IN THE PLUME WAS OPACITY DETERMINED	just above stack tip (6")
DESCRIBE BACKGROUND	clear sky w/some light haze in distance
BACKGROUND COLOR	light blue sky
SKY CONDITIONS	clear w/some haze along horizon
WIND SPEED	16 KTS
WIND DIRECTION	E 360
AMBIENT TEMPERATURE	63°
RELATIVE HUMIDITY	31% (sp=29,460)

SOURCE LAYOUT SKETCH

DRAW NORTH ARROW



OBSERVATION DATE	START TIME	STOP TIME
11 Jan 96	10:30 CST	11:00 CST

M \ sec	0	15	30	45	M \ sec	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7	0	0	0	0	37				
8	0	0	0	0	38				
9	0	0	0	0	39				
10	0	0	0	0	40				
11	0	0	0	0	41				
12	0	0	0	0	42				
13	0	0	0	0	43				
14	0	0	0	0	44				
15	0	0	0	0	45				
16	0	0	0	0	46				
17	0	0	0	0	47				
18	0	0	0	0	48				
19	0	0	0	0	49				
20	0	0	0	0	50				
21	0	0	0	0	51				
22	0	0	0	0	52				
23	0	0	0	0	53				
24	0	0	0	0	54				
25	0	0	0	0	55				
26	0	0	0	0	56				
27	0	0	0	0	57				
28	0	0	0	0	58				
29	0	0	0	0	59				
30	0	0	0	0	60				

AVERAGE OPACITY FOR HIGHEST PERIOD	0
NUMBER OF READINGS ABOVE % WERE	
RANGE OF OPACITY READINGS	0 MINIMUM 0 MAXIMUM
OBSERVER'S NAME (PRINT)	THOMAS C. MOORE
OBSERVER'S SIGNATURE	Thomas C. Moore
DATE	11 Jan 96
ORGANIZATION	USAF (AL/OEBQ, Brooks AFB TX)
CERTIFIED BY	Philip J. Clark (TNRCC)
DATE	15 Sep 95
VERIFIED BY	
DATE	

COMMENTS

I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS

SIGNATURE

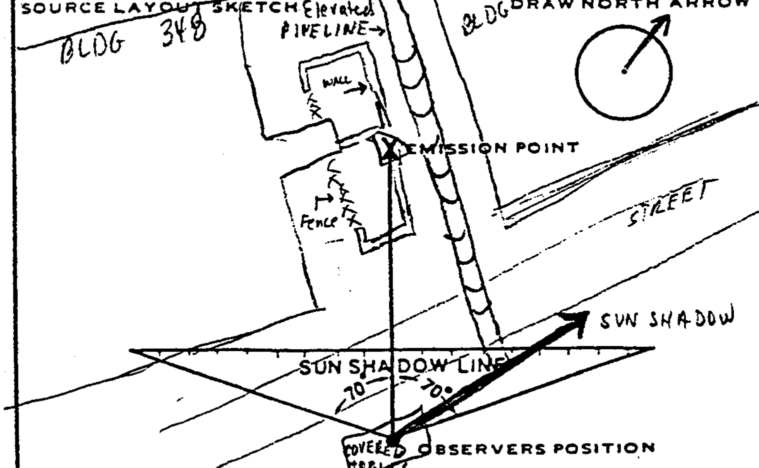
TITLE

DATE

VISIBLE EMISSION OBSERVATION FORM

SOURCE NAME	USAF Fuel Accessories Repair & Test Facility Incinerator
ADDRESS	
CITY	Kelly AFB
STATE	TX
ZIP	
PHONE	
SOURCE ID NUMBER	
PROCESS EQUIPMENT	Thermal Oxidizer
OPERATING MODE	70%
CONTROL EQUIPMENT	Allen Bradley PLC-5
OPERATING MODE	Automatic
DESCRIBE EMISSION POINT	(Square Stack with triangular inside) tan brick incinerator stack located in fenced/walled area on north side of bldg 348
HEIGHT ABOVE GROUND LEVEL	30'
HEIGHT RELATIVE TO OBSERVER	30'
DISTANCE FROM OBSERVER	250'
DIRECTION FROM OBSERVER	320°
DESCRIBE EMISSIONS	emission/plume characteristics not visually detectable
EMISSION COLOR	clear
PLUME TYPE:	CONTINUOUS ☒ FUGITIVE ☐ INTERMITTENT ☐
WATER DROPLETS PRESENT	NO ☒ YES ☐
IS WATER DROPLET PLUME	ATTACHED ☐ DETACHED ☐
AT WHAT POINT IN THE PLUME WAS OPACITY DETERMINED	just above stack tip (6")
DESCRIBE BACKGROUND	Clear sky
BACKGROUND COLOR	Blue Sky
SKY CONDITIONS	Clear
WIND SPEED	15 KTS
WIND DIRECTION	E 340
AMBIENT TEMPERATURE	68°
RELATIVE HUMIDITY	14% 29.41

SOURCE LAYOUT SKETCH   DRAW NORTH ARROW



OBSERVATION DATE	11 Jan 95
START TIME	1:45 CST
STOP TIME	2:15 CST

M \ sec	0	15	30	45	M \ sec	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7	0	0	0	0	37				
8	0	0	0	0	38				
9	0	0	0	0	39				
10	0	0	0	0	40				
11	0	0	0	0	41				
12	0	0	0	0	42				
13	0	0	0	0	43				
14	0	0	0	0	44				
15	0	0	0	0	45				
16	0	0	0	0	46				
17	0	0	0	0	47				
18	0	0	0	0	48				
19	0	0	0	0	49				
20	0	0	0	0	50				
21	0	0	0	0	51				
22	0	0	0	0	52				
23	0	0	0	0	53				
24	0	0	0	0	54				
25	0	0	0	0	55				
26	0	0	0	0	56				
27	0	0	0	0	57				
28	0	0	0	0	58				
29	0	0	0	0	59				
30	0	0	0	0	60				

AVERAGE OPACITY FOR HIGHEST PERIOD	
NUMBER OF READINGS ABOVE % WERE	
RANGE OF OPACITY READINGS	MINIMUM: MAXIMUM
COMMENTS	
OBSERVER'S NAME (PRINT)	THOMAS C. MOORE
OBSERVER'S SIGNATURE	Thomas C. Moore
DATE	11 Jan 96
ORGANIZATION	USAF (AL/OEBQ, Brooks AFB TX)
CERTIFIED BY	Philip J. Clark (TNRCC)
DATE	15 Sep 95
VERIFIED BY	
DATE	
I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS	
SIGNATURE	
TITLE	
DATE	

ENERAC Field Data Sheet

Base: Kelly AFB	Date: 10 JAN
Source: SUE Incinerator	
Run #: 1	
Fuel Type:	
Recorder's Name: JAG	

Calibration Information: S/N 31000106 Model 3000 Cal'd by: the JAGMAN

Date/Time Analyzer was last zeroed: 10 JAN / 1332

Date/Time Analyzer was last calibrated: 9 JAN / 2259

Sampling Data: (Note - readings should be taken at 2-minute intervals)

Time	O_2 (%)	CO (ppm)	SO_2 (ppm)	CO_2 (%)	NO (ppm)	NO_2 (ppm)	NO_X (ppm)	Comments
1416	18.8	95	3	1.6	25	0	25	
18	18.8	93	3	1.6	25	0		
20	18.8	94	3	1.6	25	0		
22	18.8	93	3	1.6	25	0		
24	18.8	95	0	1.6	25	0		
26	18.8	97	0	1.6	25	0		
28	18.8	97	0	1.6	25	0		
30	18.8	97	3	1.6	25	0		
32	18.8	9.3	0	1.6	25	0		
34	18.8	90	3	1.6	25	0		
36	18.8	90	3	1.6	25	0		
38	18.8	88	3	1.6	25	0		
40	18.8	90	3	1.6	25	0		
42	18.8	91	3	1.6	25	0		
44	18.8	88	3	1.6	25	0		
46	18.8	90	3	1.6	25	0		Good Job
48	18.8	90	3	1.6	25	0		
50	18.8	90	3	1.6	27	0		
52	18.9	90	3	1.6	27	0		
54	18.8	89	3	1.6	27	0		
56	18.8	89	3	1.6	27	0		
58	18.9	88	3	1.6	27	0		
1500	18.9	90	3	1.6	27	0		
02	18.9	90	3	1.5	27	0		
04	18.9	88	3	1.5	27	0		
06	18.9	87	3	1.5	25	0		
08	18.9	90	3	1.5	25	0		
10	18.9	90	3	1.5	26	0		
12	18.9	88	3	1.6	27	0		
14	18.9	86	3	1.5	27	0		
16	18.9	83	3	1.5	27	0		
Average =	18.8	91	3	1.6	26	0		

Nov 95

Operator: **KURT D. JAGIELSKI, MSgt, USAF**
~~Superintendent, Air Quality and~~
Hazardous Waste Branch

Signature: [signature]

ENERAC Field Data Sheet

Base: KELLY

Date: 11 JAN 96

Source: SUE Incinerator

Run #: 2

Fuel Type:

Recorder's Name: JAG

Calibration Information:

Date/Time Analyzer was last zeroed: 11 JAN/1139

Date/Time Analyzer was last calibrated: 9 JAN/2259

Sampling Data: (Note - readings should be taken at 2-minute intervals)

Time	O_2 (%)	CO (ppm)	SO_2 (ppm)	CO_2 (%)	NO (ppm)	NO_2 (ppm)	NO_X (ppm)	Comments
1155	18.7	133	0	1.7	25	0		
57	18.7	128	0	1.7	25	0		
59	18.6	121	0	1.8	28	0		
1201	18.4	116	0	1.9	34 ✓	0		
03	18.5	114	0	1.8	29	0		
05	18.7	118	0	1.7	27	0		
07	18.7	115	0	1.7	27	0		
09	18.7	111	0	1.7	27	0		
11	18.6	107	0	1.8	31	0		
13	18.4	100	0	1.9	35 ✓	0		
15	18.6	102	0	1.7	28	0		
17	18.7	104	0	1.6	27	0		
19	18.7	104	0	1.6	27	0		
21	18.8	102	0	1.6	27	0		
23	18.6	97	0	1.8	31	0		
25	18.4	93	0	1.9	36 ✓	0		
27	18.7	97	0	1.7	28	0		
29	18.8	104	0	1.6	27	0		
31	18.8	102	0	1.6	27	0		
33	18.8	104	0	1.6	28	0		
35	18.6	102	0	1.7	31	0		
37	18.5	106	0	1.8	35 ✓	0		
39	18.5	109	0	1.8	35	0		
41	18.7	110	0	1.6	28	0		
43	18.8	113	0	1.6	27	0		
45	18.8	112	0	1.6	27	0		
47	18.8	109	0	1.6	27	0		
49	18.8	106	0	1.6	27	0		
51	18.8	106	0	1.6	27	0		
53	18.8	106	0	1.6	27	0		
55	18.7	106	0	1.7	30	0		
Average =	18.7	108	0	1.7	29	0		

Nov 95

Operator: ~~KURT D. JAGIELSKI, MSgt, USAF~~
Superintendent, Air Quality and Hazardous Waste Branch

Signature: [signature]

ENERAC Field Data Sheet

Base: KELLY | Date: 11 JAN 96

Source: SUE Incinerator

Run #: 3

Fuel Type:

Recorder's Name: JAG

Calibration Information:

Date/Time Analyzer was last zeroed: 11JAN/1426

Date/Time Analyzer was last calibrated: 9JAN / 2259

Sampling Data: (Note - readings should be taken at 2-minute intervals)

Time	O_2 (%)	CO (ppm)	SO_2 (ppm)	CO_2 (%)	NO (ppm)	NO_2 (ppm)	NO_X (ppm)	Comments
1442	18.8	62	0	1.6	32	0		
44	18.8	60	0	1.6	33	0		
46	19.0	62	0	1.5	28	0		
48	19.0	62	0	1.5	27	0		
50	18.8	60	0	1.6	31	0		
52	18.6	53	0	1.7	38	0		
54	18.6	51	0	1.7	38	0		
56	18.9	59	0	1.5	28	0		
58	19.0	58	0	1.5	28	0		
1500	19.0	58	0	1.5	27	0		
02	19.0	57	0	1.5	27	0		
04	18.9	58	0	1.5	29	0		
06	18.7	53	0	1.6	31	0		
08	18.8	53	0	1.6	33	0		
10	18.8	53	0	1.6	34	0		
12	18.7	48	0	1.7	36	0		
14	19.0	53	0	1.5	28	0		
16	18.9	53	0	1.5	28	0		
18	18.9	53	0	1.6	32	0		
20	18.8	51	0	1.5	30	0		
22	18.8	53	0	1.6	32	0		
24	18.8	53	0	1.6	32	0		
26	18.9	51	0	1.6	32	0		
28	18.8	51	0	1.6	33	0		
30	18.8	48	0	1.6	33	0		
32	18.8	49	0	1.6	32	0		
34	19.0	53	0	1.5	28	0		
36	18.8	50	0	1.6	33	0		
38	18.8	48	0	1.6	33	0		
40	19.0	51	0	1.5	27	0		
42	18.8	48	0	1.6	31	0		
Average =	18.8	54	0	1.6	31	0		

Nov 95

Operator: KURT D. JAGIELSKI, MSgt, USAF
~~Superintendent, Air Quality and~~
Hazardous Waste Branch

Signature: Kurt Jagielski

VOC Emissions Data Sheet

Base: KELLY AFB	Date: 10 JAN 96
Source: INCINERATOR	Run #: 1

Calibration Data: (Note - meter readings should be within ± 5% of actual gas concentrations)

		Gas Concentration (ppm)	Meter Reading (ppm)	Time
74=4	Zero:	0	-0	1307
6=4	High Span:	80.2	80.2	1312
	Mid Span:	49.1	49.7	1314
	Low Span:	24.4	25.2	1316

System bias check using High Span Gas: 85.0

Sampling Data: (Note - readings should be taken at 1-minute intervals)

Time	Reading (ppm)	Comments	Time	Reading (ppm)	Comments
14:16	16.4		14:48	14.2	
:17	16.0		49	14.2	
18	15.4		50	14.2	
19	15.4		51	13.6	
20	17.0		52	14.6	
21	16.1		53	14.1	
22	15.6		54	13.9	
23	15.9		55	13.7	
24	17.3		56	13.7	
25	17.8		57	13.2	
26	18.0		58	13.5	
27	18.0		14:59	13.5	
28	19.9		15:00	13.2	INCINERATOR TEMP WAS
29	18.1		15:01	13.0	INCREASED BY 20°
14:30	17.8		02	13.0	DURING PERIOD SO DECREASE
31	17.9	TEMP	03	12.6	IN READINGS SHOULD BE
32	16.4	INCREASE	04	12.7	OBSERVED
33	15.5		05	12.6	Fuel rate also increased
34	15.4		06	13.5	from 107 to 109 pph
35	14.9		07	13.4	
36	15.4		08	13.3	
37	14.3		09	12.9	
38	15.4		10	12.9	
39	15.3		11	12.9	
40	16.2		12	12.6	
41	15.6		13	12.8	
42	15.6		14	12.8	
43	14.9		15	12.6	
44	14.8		16	13.0	
45	14.8		17	13.2	
46	14.6		18	12.7	
14:47	14.0		19	13.2	
			Average =	14.7	

Nov 95

Operator: LT KYLE BLASCH Signature: Kyle Blasch

VOC Emissions Data Sheet

Base: KELLY AFB	Date: 11 JAN 96
Source: INCINERATOR	Run #: 2

Calibration Data: (Note - meter readings should be within ± 5% of actual gas concentrations)

	Gas Concentration (ppm)	Meter Reading (ppm)	Time
Zero:	Ø	Ø	10:32
High Span:	8Ø.2	80.2	10:4Ø
Mid Span:	49.6	49.6	10:45
Low Span:	24.4	25.Ø	10:51
SYSTEM BIAS CHECK	80.2	81.1	11:26

Sampling Data: (Note - readings should be taken at 1-minute intervals)

Time	Reading (ppm)	Comments	Time	Reading (ppm)	Comments
11:55	13.1		12:27	6.8	
11:56	12.3		12:28	7.5	
11:57	1Ø.9		29	7.8	
11:58	1Ø.7		30	7.6	
11:59	1Ø.1		31	7.8	
12:00	9.0		32	8.7	
:01	8.8		33	8.7	
02	8.4		34	8.6	
03	8.5		35	8.4	
Ø4	8.4		36	9.2	
05	8.8		37	9.2	
06	8.7		38	9.4	
07	8.8		39	8.9	
Ø8	8.5		40	10.2	
Ø9	8.1		41	1Ø.7	
1Ø	7.5		42	1Ø.9	
11	7.4		43	11.1	
12	7.7		44	1Ø.7	
13	7.3		45	1Ø.8	
14	7.9		46	1Ø.7	
15	6.9		47	1Ø.6	
16	7.Ø		48	1Ø.7	
17	7.3		49	1Ø.8	
18	7.4		50	1Ø.8	
19	7.6		51	1Ø.9	
2Ø	7.4		52	1Ø.8	
21	7.7		53	11.4	
22	7.4		54	11.6	
23	7.2		55	11.1	
24	7.5		56	11.2	
25	7.5		57	1Ø.7	
12:26	7.4		12:58	1Ø.4	
			Average =	9.1	

Nov 95

Operator: KYLE BLASCH   Signature: Kyle Blasch

VOC Emissions Data Sheet

Base:	KELLY AFB	Date:	11 JAN 96
Source:	INCINERATOR	Run #:	3

Calibration Data: (Note - meter readings should be within ± 5% of actual gas concentrations)

	Gas Concentration (ppm)	Meter Reading (ppm)	Time
Zero:	Ø	Ø	1346
High Span:	80.2	80.2	1350
Mid Span:	49.6	49.9	1353
Low Span:	24.4	24.9	1357

Sampling Data: (Note - readings should be taken at 1-minute intervals)

Time	Reading (ppm)	Comments	Time	Reading (ppm)	Comments
14:42	7.7		15:14	7.6	
43	7.7		15	7.3	
44	7.8		16	7.4	
45	7.9		17	7.9	
46	7.Ø		18	8.5	
47	7.4		19	9.5	
48	7.4		20	8.Ø	
49	7.3		21	8.2	
50	8.2		22	8.5	
51	8.6		23	8.Ø	
52	9.2		24	8.Ø	
53	9.2		25	7.8	
54	9.Ø		26	7.7	
55	7.2		27	8.Ø	
56	7.4		28	8.Ø	
57	7.5		29	8.Ø	
58	7.3		30	7.8	
59	7.8		31	7.9	
15:00	7.6		32	7.8	
01	8.Ø		33	7.3	
02	8.2		34	7.6	
03	9.1		35	7.7	
04	9.1		36	8.3	
05	9.8		37	8.Ø	
06	8.6		38	8.1	
07	8.9		39	7.4	
08	8.8		40	7.6	
09	8.5		41	8.6	
10	9.Ø		42	7.8	
11	9.Ø		43	8.Ø	
12	8.8		44	8.4	
15:13	7.Ø		15:45	7.6	
			Average =	8.1	

Nov 95

Operator: KYLE BLASCH Signature: Kyle Blasch

StMarch 1/11/96

Calibration Fluid Consumption During Emissions Testing of SUE Incinerator

Sample Run #	Initial Fluid Reading (lb)	End Fluid Reading (lb)	Fuel Consumed (lb)	Initial Fluid Flow Rate Reading (pph)	End Fluid Flow Rate Reading (pph)	Average Fluid Flow Rate Reading (pph)
1	Not Recorded	Not Recorded	—	107	109	108
2	Not Recorded	Not Recorded	—	1075	107.2	107
3	19199	19307	108	108.1	107.5	108

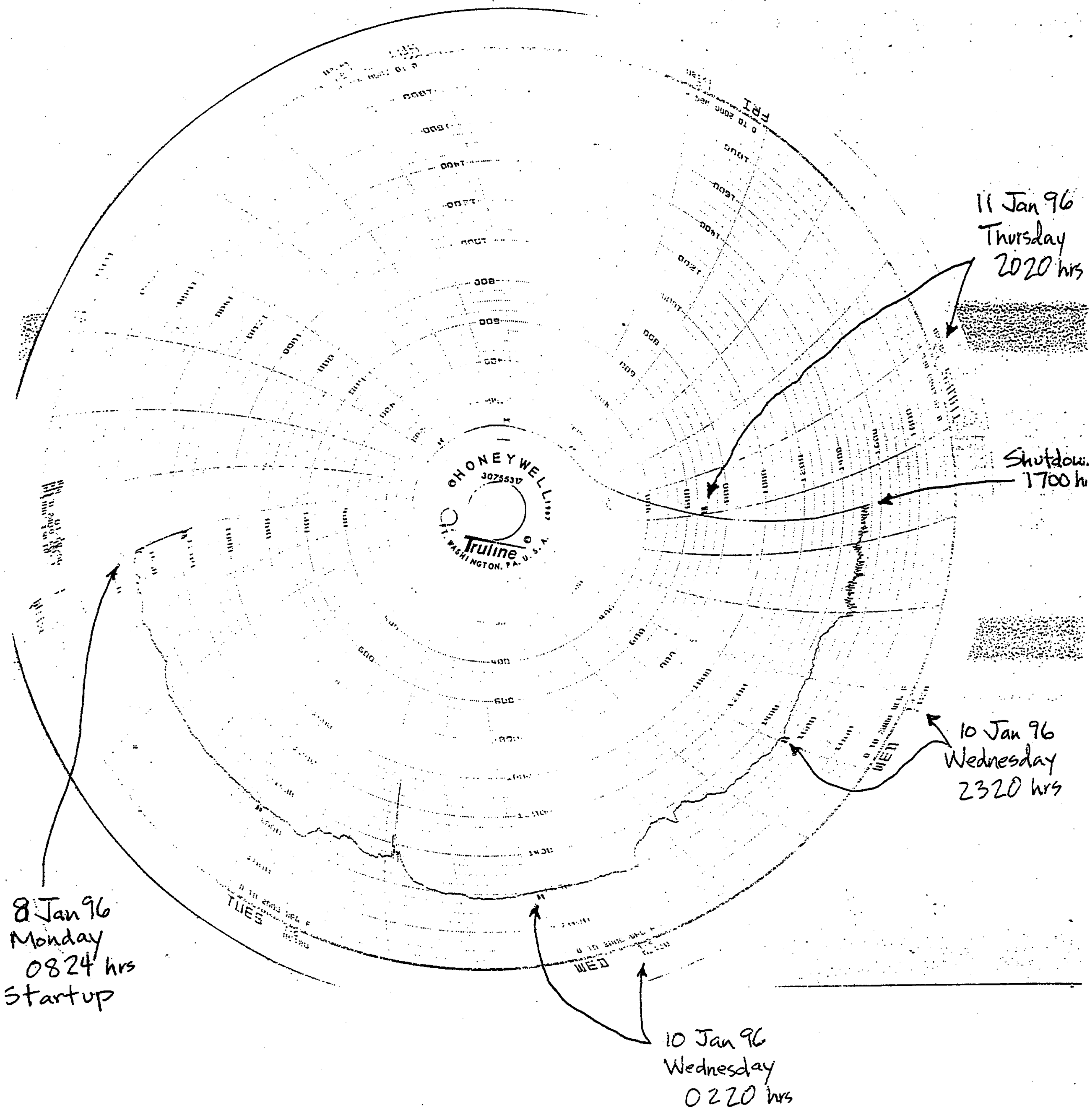
Incinerator Burner Temperatures During Emissions Testing of SUE Incinerator

Sample Run #	Set Burner Temperature (°F)	Initial Burner Temperature (°F)	End Burner Temperature (°F)	Average Burner Temperature (°F)
1	1470	Not Recorded	Not Recorded	—
2	1512	1510	1529	1515
3	1515	1520	1520	1520

Sampling Date/Time

Run #1: 10 Jan 96 1416 - 1516 hrs
Run #2: 11 Jan 96 1155 - 1255 hrs
Run #3: 11 Jan 96 1442 - 1542 hrs

SUE Incinerator Temperature Chart During Exhaust Stack Sampling



APPENDIX E

Calibration Data

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 7 June 95 Meter box number 6

Barometric pressure, P_b = 28.990 in. Hg Calibrated by Dobbins / JAG

		Gas volume		Temperatures						
					Dry gas meter					
	Orifice manometer setting (ΔH), in. H_2O	Wet test meter (V_w), ft^3	Dry gas meter (V_d), ft^3	Wet test meter (t_w), °F	Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Avg[a] (t_d), °F	Time (Θ), min	Y_i	$\Delta H@_i$ in. H_2O
5	0.5	5	4.99	72	79.5	74.5	77	12.85	1.010	1.903
5	1.0	5	4.98	72	86	77	82	9.13	1.020	1.904
5.5	1.5	10	9.995	72	91.5	80.5	86	15.24	1.023	1.975
5.0	2.0	10	10.05	72	98	85	92	13.23	1.027	1.963
6.0	3.0	10	10.075	72	~~102~~	87.5	95	10.81	1.028	1.955
6.5	4.0	10	10.085	~~72~~	104	~~88.5~~	96	9.39	1.026	1.963
								Avg	1.022	1.944

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\Theta}{V_w}\right]^2$
0.5	0.0368	5 x 28.99 (77+460) / 4.99 (28.99+.5/13.6) (72+460)	.0317 (.5) / 28.99 (77+460) [(72+460) 12.85 / 5]^2
1.0	0.0737	5 x 28.99 (82+460) / 4.98 (28.99+1.0/13.6 (72+460)	.0317 (1) / 28.99 (82+460) [(72+460) 9.13 / 5]^2
1.5	0.110	10 x 28.99 (86+460) / 9.995 (28.99+1.5/13.6 (72+460)	.0317 (1.5) / 28.99 (86+460) [(72+460) 15.24 / 10]^2
2.0	0.147	10 x 28.99 (92+460) / 10.05 (28.99+2/13.6) (72+460)	.0317 (2) / 28.99 (92+460) [(72+460) 13.23 / 10]^2
3.0	0.221	10 x 28.99 (95+460) / 10.075 (28.99+3/13.6) (72+460)	.0317 (3) / 28.99 (95+460) [(72+460) 10.81 / 10]^2
4.0	0.294	10 x 28.99 (96+460) / 10.085 (28.99+4/13.6) (72+460)	.0317 (4) / 28.99 (96+460) [(72+460) 9.34 / 10]^2

a If there is only one thermometer on the dry gas meter, record the temperature under t_d.

NOZZLE CALIBRATION DATA FORM

Kelly AFB Exhaust sampling of SUE Incinerator

Date 9 Jan 96 Calibrated by R. O'Brien

Nozzle identification number	Nozzle Diameter[a]			ΔD,[b] mm (in.)	D_{avg}[c]
	D_1, mm (in.)	D_2, mm (in.)	D_3, mm (in.)		
28	0.346	0.347	0.347	0.001	0.347

where:

[a] $D_{1,2,3}$, = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

[b] ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq$ (0.10 mm) 0.004 in.

[c] D_{avg} = average of D_1, D_2, and D_3.

6-1

TYPE S PITOT TUBE INSPECTION DATA FORM

1 Apr 93

Pitot tube assembly level? ✓ yes ______ no

Pitot tube openings damaged? ______ yes (explain below) ✓ no

α_1 = 1 ° (<10°), α_2 = 2 ° (<10°), β_1 = 1.5 ° (<5°),

β_2 = 1.5 ° (<5°)

γ = 0 °, Θ = 1.0 °, A = (0.866) cm (in.)

$z = A \sin \gamma$ = 0 cm (in.); <0.32 cm (<1/8 in.),

$w = A \sin \Theta$ = (0.015) cm (in.); <.08 cm (<1/32 in.)

P_A (0.433) cm (in.) P_b (0.433) cm (in.)

D_t = (0.372) cm (in.)

Comments: Calibrated by O'Brien and Jagielski

Calibration required? ______ yes ✓ no

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 2 Apr 93 Thermocouple number 6-1

Ambient temperature 22.2 °C Barometric pressure 29.250 in. Hg

Calibrator O'Brien/ Jagielski Reference: mercury-in-glass ASTM 3F

other ____________

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
0	Ice water	0.0	1.1	0.40
100	Boiling water	99.2	100.6	0.38
—	Heated corn oil	298.9	304.4	0.96

[a]Every 30°C (50°F) for each reference point.

[b]Type of calibration system used.

[c]$\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%$.

APPENDIX F

HP 41 Program Printouts

HP 41 “METH 4” Program Printouts for Exhaust Stack Sampling Runs 1, 2, & 3

Kelly AFB
Incinerator Testing
Run 1   10 Jan 96

```
            XROM "METH 4"
METER BOX Y?
            1.0220      RUN
DELTA H?
            1.7000      RUN
BAR PRESS ?
           29.3050      RUN
METER VOL ?
           42.0820      RUN
MTR TEMP F?
           83.0000      RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
                        RUN
STATIC HOH IN ?
            -.2000      RUN
STACK TEMP.
          606.0000      RUN
ML. WATER ?
           26.0000      RUN


IMP. % HOH = 2.9

% HOH=2.9
```

Kelly AFB
Incinerator Testing
Run 2   11 Jan 96

```
            XROM "METH 4"
METER BOX Y?
            1.0220      RUN
DELTA H?
            1.7000      RUN
BAR PRESS ?
           29.4600      RUN
METER VOL ?
           42.3230      RUN
MTR TEMP F?
           85.0000      RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
                        RUN
STATIC HOH IN ?
            -.2000      RUN
STACK TEMP.
          632.0000      RUN
ML. WATER ?
           15.0000      RUN


IMP. % HOH = 1.7

% HOH=1.7
```

Kelly AFB
Incinerator Testing
Run 3   11 Jan 96

```
            XROM "METH 4"
METER BOX Y?
            1.0220      RUN
DELTA H?
            1.7000      RUN
BAR PRESS ?
           29.4100      RUN
METER VOL ?
           42.4280      RUN
MTR TEMP F?
           84.0000      RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
                        RUN
STATIC HOH IN ?
            -.2000      RUN
STACK TEMP.
          629.0000      RUN
ML. WATER ?
           19.0000      RUN


IMP. % HOH = 2.1

% HOH=2.1
```

HP 41 "METH 2" Program Printout for Exhaust Stack Sampling Run 1

```
        XROM "METH 2"
SITE ?
KELLY AFB INCINERATOR
STACK, RUN 1, 10 JAN 96
                      RUN
STACK DIA INCH?
                      RUN
AREA SQ FT ?
         8.0000       RUN
NO TRAV PTS. ?
        16.0000       RUN
BAR PRESS ?
        29.3050       RUN
STATIC IN HOH ?
        -.2000        RUN
% MOISTURE ?
         2.9000       RUN
PITOT CP ?
          .8400       RUN
% CO2 ?
         1.6000       RUN
% OXYGEN ?
        18.8000       RUN
% CO ?
                      RUN
MOL WT OTHER ?
                      RUN

MWd = 29.01
MW WET = 28.69


DELTA P 1.
              .355    RUN
STACK TEMP?
              603.    RUN
FPS = 48.

DELTA P 2.
              .350    RUN
STACK TEMP?
              609.    RUN
FPS = 48.

DELTA P 3.
              .263    RUN
STACK TEMP?
              610.    RUN
FPS = 41.

DELTA P 4.
              .210    RUN
STACK TEMP?
              611.    RUN
FPS = 37.

DELTA P 5.
              .175    RUN
STACK TEMP?
              609.    RUN
FPS = 34.

DELTA P 6.
              .145    RUN
STACK TEMP?
              605.    RUN
FPS = 31.

DELTA P 7.
              .115    RUN
STACK TEMP?
              602.    RUN
FPS = 27.

DELTA P 8.
              .412    RUN
STACK TEMP?
              609.    RUN
FPS = 52.

DELTA P 9.
              .275    RUN
STACK TEMP?
              610.    RUN
FPS = 42.

DELTA P 10.
              .151    RUN
STACK TEMP?
              611.    RUN
FPS = 32.

DELTA P 11.
              .128    RUN
STACK TEMP?
              611.    RUN
FPS = 29.

DELTA P 12.
              .160    RUN
STACK TEMP?
              611.    RUN
FPS = 32.

DELTA P 13.
              .461    RUN
STACK TEMP?
              600.    RUN
FPS = 55.

DELTA P 14.
              .360    RUN
STACK TEMP?
              607.    RUN
FPS = 49.

DELTA P 15.
              .225    RUN
STACK TEMP?
              608.    RUN
FPS = 38.

DELTA P 16.
              .430    RUN
STACK TEMP?
              577.    RUN
FPS = 52.

AVE FPS = 41.
AVE FPM = 2,430.
AVE DELTA P = 0.26
STK PRS. ABS = 29.29
AVE STK TEMP = 606.
STACK ACFM = 19,440.
DSCFM = 9,155.
```

HP 41 "METH 2" Program Printout for Exhaust Stack Sampling Run 2

```
            XROM "METH 2"
SITE ?
KELLY AFB INCINERATOR
STACK, RUN 3, 11 JAN 96
                         RUN
STACK DIA INCH?
                         RUN
AREA SQ FT ?
            8.0000       RUN
NO TRAV PTS. ?
           16.0000       RUN
BAR PRESS ?
           29.4100       RUN
STATIC IN HOH ?
            -.2000       RUN
% MOISTURE ?
            2.1000       RUN
PITOT CP ?
             .8400       RUN
% CO2 ?
            1.6000       RUN
% OXYGEN ?
           18.8000       RUN
% CO ?
                         RUN
MOL WT OTHER ?
                         RUN

MWd = 29.01
MW WET = 28.78


DELTA P 1.
                .340     RUN
STACK TEMP?
                633.     RUN
FPS = 48.

DELTA P 2.
                .355     RUN
STACK TEMP?
                639.     RUN
FPS = 49.

DELTA P 3.
                .270     RUN
STACK TEMP?
                638.     RUN
FPS = 43.

DELTA P 4.
                .240     RUN
STACK TEMP?
                641.     RUN
FPS = 40.

DELTA P 5.
                .195     RUN
STACK TEMP?
                640.     RUN
FPS = 36.

DELTA P 6.
                .150     RUN
STACK TEMP?
                634.     RUN
FPS = 32.

DELTA P 7.
                .125     RUN
STACK TEMP?
                630.     RUN
FPS = 29.

DELTA P 8.
                .415     RUN
STACK TEMP?
                631.     RUN
FPS = 53.

DELTA P 9.
                .280     RUN
STACK TEMP?
                633.     RUN
FPS = 43.

DELTA P 10.
                .178     RUN
STACK TEMP?
                635.     RUN
FPS = 34.

DELTA P 11.
                .132     RUN
STACK TEMP?
                635.     RUN
FPS = 30.

DELTA P 12.
                .170     RUN
STACK TEMP?
                635.     RUN
FPS = 34.

DELTA P 13.
                .445     RUN
STACK TEMP?
                619.     RUN
FPS = 54.

DELTA P 14.
                .368     RUN
STACK TEMP?
                635.     RUN
FPS = 50.

DELTA P 15.
                .250     RUN
STACK TEMP?
                633.     RUN
FPS = 41.

DELTA P 16.
                .419     RUN
STACK TEMP?
                557.     RUN
FPS = 51.

AVE FPS = 42.
AVE FPM = 2,492.
AVE DELTA P = 0.27
STK PRS. ABS = 29.40
AVE STK TEMP = 629.
STACK ACFM = 19,940.
DSCFM = 9,297.
```

HP 41 "METH 2" Program Printout for Exhaust Stack Sampling Run 3

```
            XROM "METH 2"
SITE ?
KELLY AFB INCINERATOR
STACK, RUN 2, 11 JAN 96
                          RUN
STACK DIA INCH?
                          RUN
AREA SQ FT ?
            8.0000        RUN
NO TRAV PTS. ?
           16.0000        RUN
BAR PRESS ?
           29.4600        RUN
STATIC IN HOH ?
            -.2000        RUN
% MOISTURE ?
            1.7000        RUN
PITOT CP ?
             .8400        RUN
% CO2 ?
            1.7000        RUN
% OXYGEN ?
           18.7000        RUN
% CO ?
                          RUN
MOL WT OTHER ?
                          RUN

MWd = 29.02
MW WET = 28.83


DELTA P 1.
              .340        RUN
STACK TEMP?
              630.        RUN
FPS = 47.

DELTA P 2.
              .350        RUN
STACK TEMP?
              632.        RUN
FPS = 48.

DELTA P 3.
              .285        RUN
STACK TEMP?
              641.        RUN
FPS = 44.

DELTA P 4.
              .225        RUN
STACK TEMP?
              638.        RUN
FPS = 39.

DELTA P 5.
              .185        RUN
STACK TEMP?
              636.        RUN
FPS = 35.

DELTA P 6.
              .135        RUN
STACK TEMP?
              638.        RUN
FPS = 30.

DELTA P 7.
              .113        RUN
STACK TEMP?
              632.        RUN
FPS = 27.

DELTA P 8.
              .416        RUN
STACK TEMP?
              633.        RUN
FPS = 53.

DELTA P 9.
              .285        RUN
STACK TEMP?
              638.        RUN
FPS = 44.

DELTA P 10.
              .144        RUN
STACK TEMP?
              636.        RUN
FPS = 31.

DELTA P 11.
              .120        RUN
STACK TEMP?
              636.        RUN
FPS = 28.

DELTA P 12.
              .155        RUN
STACK TEMP?
              638.        RUN
FPS = 32.

DELTA P 13.
              .410        RUN
STACK TEMP?
              608.        RUN
FPS = 52.

DELTA P 14.
              .348        RUN
STACK TEMP?
              632.        RUN
FPS = 48.

DELTA P 15.
              .210        RUN
STACK TEMP?
              631.        RUN
FPS = 37.

DELTA P 16.
              .436        RUN
STACK TEMP?
              610.        RUN
FPS = 53.

AVE FPS = 41.
AVE FPM = 2,431.
AVE DELTA P = 0.26
STK PRS. ABS = 29.45
AVE STK TEMP = 632.
STACK ACFM = 19,446.
DSCFM = 9,097.
```

HP 41 "WBDB" Program Printouts for Inlet Duct Sampling Runs 1, 2, & 3

Kelly AFB
Inlet Duct, Run 1
19 Jul 95

```
              XROM "WBDB"
P BAR ?
          29.2600     RUN
STATIC HOH?
          -1.4600     RUN
DRY BULB TEMP?
          82.0000     RUN
WET BULB TEMP?
          70.0000     RUN
V.P. WET BULB?
           0.7392     RUN
% HOH = 2.1
```

Kelly AFB
Inlet Duct, Run 2
20 Jul 95

```
              XROM "WBDB"
P BAR ?
          29.2050     RUN
STATIC HOH?
          -1.4600     RUN
DRY BULB TEMP?
          80.0000     RUN
WET BULB TEMP?
          70.0000     RUN
V.P. WET BULB?
           0.7392     RUN
% HOH = 2.2
```

Kelly AFB
Inlet Duct, Run 3
20 Jul 95

```
              XROM "WBDB"
P BAR ?
          29.2050     RUN
STATIC HOH?
          -1.4600     RUN
DRY BULB TEMP?
          84.0000     RUN
WET BULB TEMP?
          70.0000     RUN
V.P. WET BULB?
           0.7392     RUN
% HOH = 2.0
```

HP 41 "METH 2" Program Printout for Inlet Duct Sampling Run 1

```
          XROM "METH 2"
SITE ?
KELLY AFB
SUE INCINERATOR
INLET DUCT, RUN 1
                              RUN
STACK DIA INCH?
                              RUN
AREA SQ FT ?
            10.0000           RUN
NO TRAV PTS. ?
            16.0000           RUN
BAR PRESS ?
            29.2600           RUN
STATIC IN HOH ?
            -1.4600           RUN
% MOISTURE ?
             2.1000           RUN
PITOT CP ?
              .8400           RUN
% CO2 ?
                              RUN
% OXYGEN ?
            20.9000           RUN
% CO ?
                              RUN
MOL WT OTHER ?
                              RUN

MWd = 28.97
MW WET = 28.74


DELTA P 1.
              .05         RUN
STACK TEMP?
              87.         RUN
FPS = 13.

DELTA P 2.
              .08         RUN
STACK TEMP?
              85.         RUN
FPS = 16.

DELTA P 3.
              .078        RUN
STACK TEMP?
              83.         RUN
FPS = 16.

DELTA P 4.
              .04         RUN
STACK TEMP?
              85.         RUN
FPS = 12.

DELTA P 5.
              .08         RUN
STACK TEMP?
              85.         RUN
FPS = 16.

DELTA P 6.
              .102        RUN
STACK TEMP?
              78.         RUN
FPS = 18.
```

```
DELTA P 7.
              .105        RUN
STACK TEMP?
              77.         RUN
FPS = 19.

DELTA P 8.
              .10         RUN
STACK TEMP?
              83.         RUN
FPS = 18.

DELTA P 9.
              .102        RUN
STACK TEMP?
              77.         RUN
FPS = 18.

DELTA P 10.
              .115        RUN
STACK TEMP?
              83.         RUN
FPS = 20.

DELTA P 11.
              .10         RUN
STACK TEMP?
              78.         RUN
FPS = 18.

DELTA P 12.
              .10         RUN
STACK TEMP?
              83.         RUN
FPS = 18.

DELTA P 13.
              .15         RUN
STACK TEMP?
              82.         RUN
FPS = 22.

DELTA P 14.
              .13         RUN
STACK TEMP?
              80.         RUN
FPS = 21.

DELTA P 15.
              .139        RUN
STACK TEMP?
              81.         RUN
FPS = 22.

DELTA P 16.
              .141        RUN
STACK TEMP?
              82.         RUN
FPS = 22.

AVE FPS = 18.
AVE FPM = 1,086.
AVE DELTA P = 0.10
STK PRS. ABS = 29.15
AVE STK TEMP = 82.
STACK ACFM = 10,858.
DSCFM = 10,094.
```

HP 41 "METH 2" Program Printout for Inlet Duct Sampling Run 2

```
        XROM "METH 2"
SITE ?
KELLY AFB
SUE INCINERATOR
INLET DUCT, RUN 2
                         RUN
STACK DIA INCH?
                         RUN
AREA SQ FT ?
             10.0000     RUN
NO TRAV PTS. ?
             16.0000     RUN
BAR PRESS ?
             29.2050     RUN
STATIC IN HOH ?
             -1.4600     RUN
% MOISTURE ?
              2.2000     RUN
PITOT CP ?
               .8400     RUN
% CO2 ?
                         RUN
% OXYGEN ?
             20.9000     RUN
% CO ?
                         RUN
MOL WT OTHER ?
                         RUN

MWd = 28.97
MW WET = 28.73


DELTA P 1.
               .045      RUN
STACK TEMP?
               81.       RUN
FPS = 12.

DELTA P 2.
               .065      RUN
STACK TEMP?
               79.       RUN
FPS = 15.

DELTA P 3.
               .075      RUN
STACK TEMP?
               79.       RUN
FPS = 16.

DELTA P 4.
               .025      RUN
STACK TEMP?
               79.       RUN
FPS = 9.

DELTA P 5.
               .10       RUN
STACK TEMP?
               83.       RUN
FPS = 18.

DELTA P 6.
               .115      RUN
STACK TEMP?
               79.       RUN
FPS = 20.

DELTA P 7.
               .11       RUN
STACK TEMP?
               79.       RUN
FPS = 19.

DELTA P 8.
               .09       RUN
STACK TEMP?
               79.       RUN
FPS = 17.

DELTA P 9.
               .115      RUN
STACK TEMP?
               81.       RUN
FPS = 20.

DELTA P 10.
               .105      RUN
STACK TEMP?
               80.       RUN
FPS = 19.

DELTA P 11.
               .11       RUN
STACK TEMP?
               80.       RUN
FPS = 19.

DELTA P 12.
               .09       RUN
STACK TEMP?
               80.       RUN
FPS = 17.

DELTA P 13.
               .175      RUN
STACK TEMP?
               84.       RUN
FPS = 24.

DELTA P 14.
               .135      RUN
STACK TEMP?
               82.       RUN
FPS = 21.

DELTA P 15.
               .14       RUN
STACK TEMP?
               80.       RUN
FPS = 22.

DELTA P 16.
               .155      RUN
STACK TEMP?
               80.       RUN
FPS = 23.

AVE FPS = 18.
AVE FPM = 1,090.
AVE DELTA P = 0.10
STK PRS. ABS = 29.10
AVE STK TEMP = 80.
STACK ACFM = 10,901.
DSCFM = 10,132.
```

HP 41 "METH 2" Program Printout for Inlet Duct Sampling Run 3

```
            XROM "METH 2"
SITE ?
KELLY AFB
SUE INCINERATOR
INLET DUCT, RUN 3
                        RUN
STACK DIA INCH?
                        RUN
AREA SQ FT ?
           10.0000      RUN
NO TRAV PTS. ?
           16.0000      RUN
BAR PRESS ?
           29.2050      RUN
STATIC IN H0H ?
           -1.4600      RUN
% MOISTURE ?
            2.0000      RUN
PITOT CP ?
             .8400      RUN
% CO2 ?
                        RUN
% OXYGEN ?
           20.9000      RUN
% CO ?
                        RUN
MOL WT OTHER ?
                        RUN

MWd = 28.97
MW WET = 28.75


DELTA P 1.
                .03     RUN
STACK TEMP?
                86.     RUN
FPS = 10.

DELTA P 2.
               .055     RUN
STACK TEMP?
                83.     RUN
FPS = 14.

DELTA P 3.
               .055     RUN
STACK TEMP?
                85.     RUN
FPS = 14.

DELTA P 4.
                .04     RUN
STACK TEMP?
                82.     RUN
FPS = 12.

DELTA P 5.
                .11     RUN
STACK TEMP?
                89.     RUN
FPS = 19.

DELTA P 6.
               .115     RUN
STACK TEMP?
                84.     RUN
FPS = 20.

DELTA P 7.
               .125     RUN
STACK TEMP?
                83.     RUN
FPS = 19.

DELTA P 8.
               .095     RUN
STACK TEMP?
                84.     RUN
FPS = 18.

DELTA P 9.
                .09     RUN
STACK TEMP?
                85.     RUN
FPS = 17.

DELTA P 10.
                .12     RUN
STACK TEMP?
                84.     RUN
FPS = 20.

DELTA P 11.
               .115     RUN
STACK TEMP?
                84.     RUN
FPS = 20.

DELTA P 12.
               .095     RUN
STACK TEMP?
                84.     RUN
FPS = 18.

DELTA P 13.
               .135     RUN
STACK TEMP?
                82.     RUN
FPS = 21.

DELTA P 14.
               .145     RUN
STACK TEMP?
                84.     RUN
FPS = 22.

DELTA P 15.
               .165     RUN
STACK TEMP?
                84.     RUN
FPS = 24.

DELTA P 16.
                .16     RUN
STACK TEMP?
                86.     RUN
FPS = 23.

AVE FPS = 19.
AVE FPM = 1,085.
AVE DELTA P = 0.10
STK PRES. INS = 29.10
AVE STK TEMP = 84.
STACK ACFM = 10,847.
DSCFM = 10,028.
```

APPENDIX G

VOC Analyzer Information

GENERAL DESCRIPTION

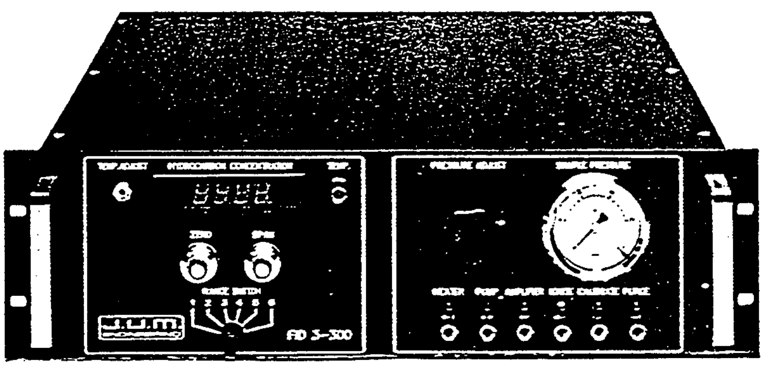
The J.U.M. Flame Ionization Analyzer Model 3-300A is an analyzer designed to continuously measure the concentration of total organic hydrocarbons in a gaseous sample. The sample can be ambient air, or the exhaust gases from a combustion process. This measurement is obtained by using the Flame Ionization Detector (FID).

The Model 3-300A is supplied in various versions through the use of options. The standard instrument has five Total Hydrocarbons measuring ranges: from 0-10 to 100,000 ppm with 10:1 Decade Range adjustment; Flame Out Indication of the front panel Dual Color LED (Red LED - Flame is Out, Green LED - Flame is Lit); 0-10 VDC Recorder Output, and two (2) internal calibration valves. Calibration gases are introduced into the analyzer using the rear panel zero gas- and span gas inlet fittings. The standard 3-300A has a backpurge function for the built-in permanent stainless mesh sample filter. This sample filter backpurge function is activated by selecting PURGE via the front panel mode turn switch. An air line (max. pressure 90 psig) must be connected to the back of the 3-300A to manually backpurge the sample filter.

J.U.M.® ENGINEERING

HEATED TOTAL HYDROCARBON ANALYZER

MODEL 3-300 A



The 3-300 A meets the requirements of EPA CFR 60, Method 25A, and EPA CFR. Method 503

The J.U.M. Engineering Model 3-300 A is a very compact, heated total hydrocarbon analyzer for high accuracy, sensitivity and stability.

The Model 3-300 A uses a hydrogen flame ionization detector (FID) in a heated oven to prevent the loss of high molecular weight hydrocarbons, and to provide reliable performance in the analysis of trace levels of contaminants in high purity gases, in air and in other gases.

The permanent sample filter is cleaned by backpurging and has a replaceable stainless mesh filter disc. A rear adapter plate allows quick installation of a heated sample line inside of the oven without the need for special tools.

Features

- 19 inch relay rack mount or table top case
- Precision 1% full scale
- Digital output display
- All heated components
- Adjustable oven temperature control up to 400 °F (204 °C)
- Permanent heated stainless steel 2 micron sample filter with replaceable disc
- Backpurge system allows filter to be cleaned without dismantling
- Fast response – within one second
- Automatic flame-out indicator with fuel shut-off valve
- Five selectable ranges can be gained by factor 10
- Automatic fuel enrichment for ignition
- Solenoid Valves for Sample, Zero Gas and Span Gas
- Remote control for sample, calibrate and backpurge is standard
- Automatic Sample Filter Backpurge (Option)

Applications

- Raw exhaust vehicle emissions
- Catalytic converter testing
- Detection of trace hydrocarbon levels in purity gases used in the semiconductor industry
- Monitors hydrocarbon contaminants in air and other gases
- Carbon adsorption regeneration control
- Measuring engine combustion efficiency
- LEL monitor of solvent-laden air
- Cryogenics/liquefaction
- Clean room applications
- Stack gas hydrocarbon emissions monitoring

Principle of Operation:

The Model 3-300 A uses the flame ionization detection (FID) method to determine the presence of total hydrocarbon concentrations in a gaseous sample.
Burning hydrocarbon free hydrogen in hydrocarbon free air produces a negligible number of ions. A hydrocarbon sample introduced into this flame starts a very complex ionization which creates a larger number of ions. A polarizing high voltage is applied between two electrodes around the burner jet and produces an electrostatic field. Now positive ions migrate to the collector electrode, and negative ions migrate to the high voltage electrode. The so generated ionization current between the two electrodes is directly proportional to the hydrocarbon concentration in the flame and is measured by the electrometer amplifier.
A sample pressure regulator provides a controlled back pressure at the sample capillary which gives admittance of a constant sample flow rate to the burner. This technique without the conventional sample back pressure regulator is used by J.U.M. Enginieering since 20 years for highest sample flow rate stability and lowest maintenance. A compactly designed flow control module for the control of fuel and air flow rates via needle valve restrictors uses high precision pressure regulators. The needle valves are adjustable for easy optimization of the burner.

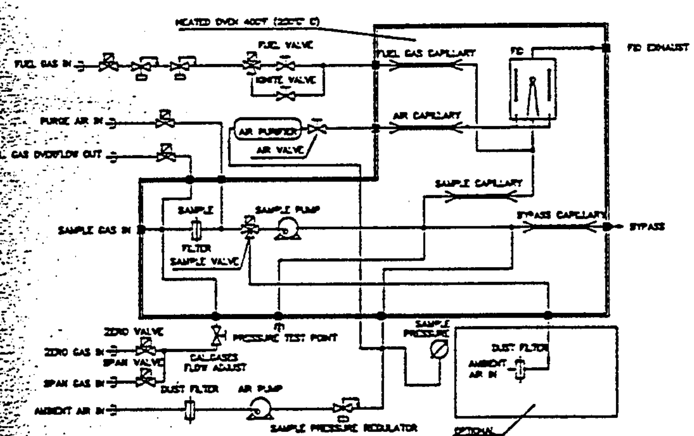
Options:

- 0–20 mA or 4–20 mA recorder output
- Adjustable 100 mVolt to 5 mVolt DC recorder output
- Remote range control
- Automatic range control

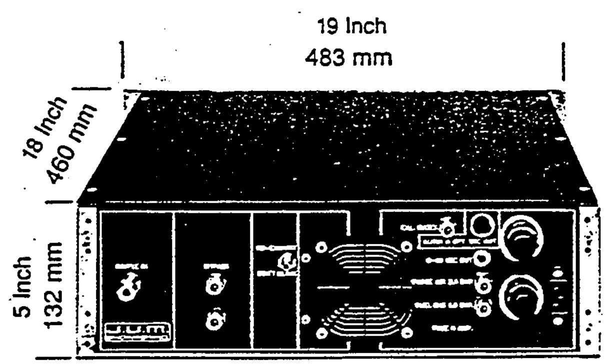
Standard specifications:

Analysis Method:	Flame Ionization Detector (FID)
Sensitivity:	Max.: 1 ppm CH_4 full scale
Response Time:	90% of full scale in less than 1 second
Zero Drift:	1.5% of full scale per 24 hours
Span Drift:	1.5% of full scale per 24 hours
Linearity:	Within 1%
Oxygen Synergism:	Less then 1% of selected range
Ranges:	Any five of the following: 0–10, 100, 1000, 10.000, 100.000 ppm or 50, 100, 500, 1000, 5000, 10.000 or 0–100% LEL or other to be specified
Outputs:	0–10 Volts D.C. and 4–20 mA
Display:	Digital
Zero/Span Adjust:	Manual on front panel
Fuel Consumption:	Hydrogen: 20 cc min at 22 psig (1.5 Bar) 40% H_2/60% He: 80 cc min at 22 psig (1.5 Bar)
Analysis Temperature:	Adjustable 200 to 400 °F (93 to 204 °C)
Power Requirements:	110 Volts, 60 Hertz AC, 800 Watts 220 Volts, 50 Hertz AC, 800 Watts (other on request)
Ambient Temperature:	41 °F to 110 °F (5 to 43 °C)
Dimensions:	Width 483 mm (19 inch) Depth 460 mm (18 inch) Height 132 mm (5,19 inch)
Weight:	33 lbs (15 kg)

FLOW DIAGRAM



OUTLINE DIMENSIONES



J.U.M. Engineering Ges.m.b.H.: reserves the right, at any time and without notice, to change specifications presented within this data sheet, and assumes no responsibility for the application or use of devices herein described.

Warranty

J.U.M. Engineering Ges.m.b.H.: warrants each new unit of its manufacture to be free of defects in material and workmanship for one year from the date of delivery.

Made in Germany

J.U.M. Engineering Ges.m.b.H.
Liebigstraße 13
85757 Karlsfeld
Phone 011-49-8131-9 87 95
Fax 011-49-8131-9 88 94

Repr

Environmental Equipment Systems
5922 Portal Drive
Houston, TX 77096
Ph 713/723-0642
FAX 713/635-3004

Procedures Used for Calibrating VOC Analyzer

The VOC analyzer was calibrated (prior to each sample run) in the following manner:

a. A zero gas (Pure Nitrogen) was introduced into the analyzer and the Zero Control adjusted so that the analyzer read zero.

b. A high-level calibration gas, with a concentration equal to approximately 80% of the applicable analyzer span, was introduced into the analyzer and the Span Control adjusted so that the analyzer read the tagged value of the calibration gas.

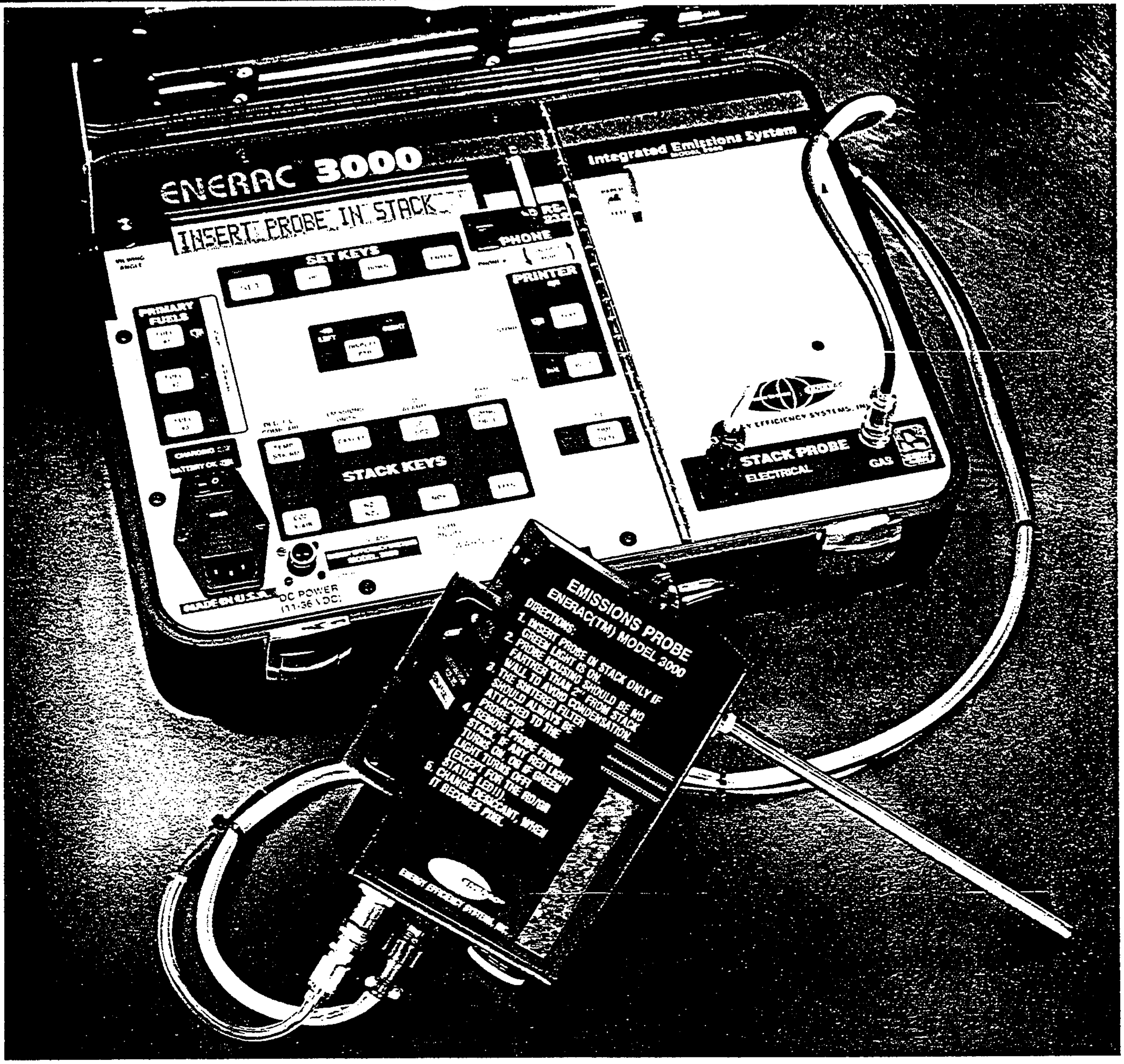
c. A mid-level calibration gas, with a concentration equal to approximately 50% of the applicable analyzer span, was then be introduced into the analyzer. The analyzer reading was compared to the tagged value of the calibration gas.

d. A low-level calibration gas, with a concentration equal to approximately 25% of the applicable analyzer span, will next introduced into the analyzer. As with the mid-level gas, the analyzer reading was then compared to the tagged value.

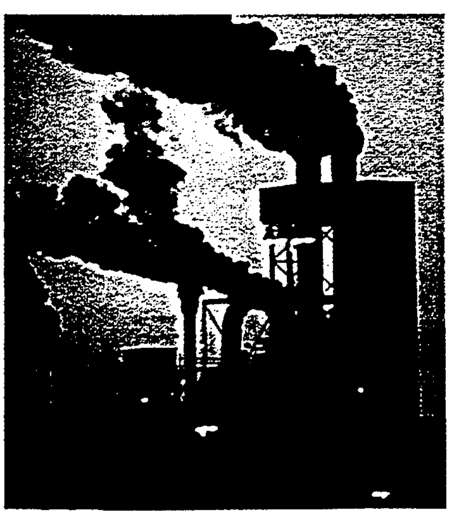
e. The analyzer was considered acceptable for testing if the readings obtained during the mid-level and low-level calibration gas checks were both within ± 5% of the tagged value.

APPENDIX H

ENERAC 3000 Analyzer Information



ENERAC™ 3000SEM



ENERAC 3000SEM quality assured, compliance level emission analyzer provides a sound, cost-effective approach to establishing a complete, comprehensive and reliable emissions database. Advanced SEM™ sensor technology, Quality Assured/Precision Control Modules (QA/PCM), Integrated Sample Conditioning System, and documented Quality Assured/Calibration Certification Protocol (QA/CCP) provide positive assurance of instrument performance, and the generation of compliance-level NO, NO_2, NO_X, SO_2, and CO data.

The ENERAC 3000SEM provides facility operators a low cost, easy-to-implement capability to develop timely and representative data for CAAA requirements:

- NO_X RACT
- Operating Permits
- CEMS Back-up
- Enhanced Monitoring
- Audits
- Emission Rates

!el 3000SEM Specifications

ICAL:

ASE: 18" x 13" x 6" Aluminum carrying case with
:k. Weight: 22 lbs.
?OBE: 24"L. x 3/8"OD. Inconel probe with
astelloy X sintered filter and 1/2" deflector mount-
: on permeation drier housing. Probe housing
onnects to instrument via a 10 ft. Viton hose.
.ax. continuous temperature: 1800 deg. F.
'ax. sample dew point (past dryer) 50 deg. F. @
)0 cc/min. (Natural gas fuel @ 0% oxygen).

TRICAL POWER:

ATTERY: 6V rechargeable, sealed lead-acid cell.
ıree hour continuous battery operation. Quick 6
our recharge.
:120V/60 Hz. and 220V/50Hz standard.
C: 11-40 VDC/3A standard.

:AY:

5" High by 24 Character single line LCD with
acklight illumination and adjustable viewing
ıgle.

TER:

EIKO 4", 40 char. per line thermal printer with line
ed button and with end of paper override.
perates in any of four modes:
EXT MODE: 25 line printout of instant values of all
ıeasured parameters. (time req. 20 sec.)
.OT MODE: Any one parameter vs. time plotted.
ordinate scales: full, half, quarter.
me scale: Selectable, 1 sec/dot-1 min/dot in 1
ec/dot intervals.
parameter plot CO-OXYGEN-NO_x-EFFICIENCY,
ıgle scale.

:ALIBRATION CERTIFICATION ROTOCOL (QA/CCP): Automatic rintout of calibration test results, ıcluding sensor and filter performance tatus and diagnostics.

XTERNAL PRINT MODE: Prints messages sent via
S-232 port.

?AGE:

ıternal: 80 individually selectable buffers hold one
omplete set of measurements each in non volatile
ıemory. Buffer contents can be sent to printer or
S-232 port.
XTERNAL (OPTIONAL): Accessory pocket computer
an store up to 300 measurements in non volatile
ıemory.

:MUNICATIONS:

S-232 PORT: RS232c port (DTE), 1200 baud
efault, 300-9600 baud user selectable, half
uplex, 1 start bit, 8 data bits, 1 stop bit, no parity.
ELEPHONE PORT: Internal 1200 baud modem
onnects to a modular phone line for remote
ommunication.
OFTWARE:
ENERCOM™ for WINDOWS® software. 3.5"
diskette, includes monitor, alarms, programming
fuels, bar graphs and multiple time plots. Also
available on DOS.
Complete package for SHARP 1600 pocket
computer

:ELLANEOUS:

FUELS: 15 fuels, 3 in foreground, 12 in
background standard. Custom fuels available
on request.
CO ALARM: Selectable 0-2000 PPM in 10 ppm steps.
COMBUSTIBLES IN ASH: Presettable 0-100% in
5% steps.
MESSAGES: User friendly diagnostic and help
messages.
CALIBRATION: Autogas span plus user selectable
auto zero on start.

MEASURED PARAMETERS	Range	Resolution	Accuracy
1. AMBIENT TEMPERATURE IC sensor Degrees F or C	0-150° F	1° F or C	3° F
2. STACK TEMPERATURE Type K thermocouple Degrees F or C	0-2,000° F (1,100° C)	1° F (1° C)	5° F
3. OXYGEN (O_2) Electrochemical cell. Life 2 years	0-25%	0.1%	0.2%
4. SEM NITRIC OXIDE (NO) ■ Electrochemical cell Life 2 years	0-1,000 PPM	1 PPM	2% of reading*
5. SEM NITROGEN DIOXIDE (NO_2) ■ Electrochemical cell. Life 2 years	0-500 PPM**	1 PPM	2% of reading*
6. SEM CARBON MONOXIDE (CO) ■ Electrochemical cell. Life 2 years	0-2,000 PPM**	1 PPM	2% of reading*
7. SEM SULFUR DIOXIDE (SO_2) ■ Electrochemical cell. Life 2 years	0-2,000 PPM**	1 PPM	2% of reading*
8. COMBUSTIBLES (GASES) Catalytic sensor. Life indefinite.	0-6%	0.01%	10% of reading in CH4 gas
9. SEM SINGLE, "DUAL RANGE" SENSOR ■ CARBON MONOXIDE (CO)	0-2,000 PPM† 0-20,000 PPM	1 PPM†	2% of reading*†
10. SEM SINGLE, "DUAL RANGE" SENSOR ■ NITRIC OXIDE (NO)	0-1,000 PPM† 0-4,000 PPM	1 PPM†	2% of reading*†
11. TIME/DATE	Time in hours, minutes, seconds. Date in month, day, year format.		

COMPUTED PARAMETERS	Range	Resolution	Accuracy
1. COMBUSTION EFFICIENCY Heat loss method. Unique four loss factors computation (dry gas, water vapor, gaseous combustibles, combustibles in ash).	0-100%	0.1%	(4 loss): 1% (above H_2O condensation) 2% (below H_2O condensation)
2. CARBON DIOXIDE (CO_2)	0-40%	0.1%	5% of reading
3. EXCESS AIR	0-1000%	1%	10% of reading
4. OXIDES OF NITROGEN (NO_x)	0-1500 PPM**	1 PPM	2% of reading*
5. EMISSIONS 1. (CO, NO_x, SO_2)	0-2500 milligrams/ cubic meter	2 mg/m3	5% of reading*
6. EMISSIONS 2. (CO, NO_x, SO_2) (Oxygen correction factor for emissions adjustable 0-20% in 1% steps plus TRUE).	0.000-9.999 lbs./ million BTU	0.001 lbs./ MMBTU	5% of reading*
7. EMISSIONS 3.	0-9.99 grams/ brake hp-hr	0.001 grms/ brake hp-hr	10% of reading*

* When tested according to 40 CFR 60, RAA test. † Low range measurements.
** Other ranges available upon request.

Operational Flexibility

Historically, Clean Air Permits have been established using emission factors – half of these permits may be grossly understated, thus reducing long term operational flexibility. Many of the strategies being developed to provide future plant operational flexibility will rely on establishing accurate, defendable and cost-effective emissions data. ENERAC 3000SEM provides the most comprehensive and complete NO_x measurement available. Numerous independent studies have demonstrated ENERAC's ability to supply data that meets EPA enhanced monitoring performance requirements.

- Passed 40 CFR 60, Appendix B Performance Specification 2
- Passed NO_x Conversion Efficiency of Method 20, 40 CFR 60, App. A
- Passed Method 6C.5.1.5 and 7E Integrated Sample Conditioning requirements, 40 CFR 60, App. A
- Received Blue Ribbon Certificate of Verification from the Center for Emissions Research & Analysis

Operator Training & Certification

SEM electrochemical portable instrumentation is an important, cost-effective method to acquire compliance-level emission data. To ensure proper implementation, the operator should be trained as to the instrument's capabilities. ENERAC offers a Factory Training and Certification Program as proposed under 40 CFR 64 and detailed in the Enhanced Monitoring Reference document.

Remote Operation

2-way advanced communication and remote operation includes remote factory check and repair, and remote operation and reporting.

Accessories

A complete line of supporting accessories is available, and includes:

- Portable Gas Calibration Kit
- Dilution Kit for very high concentrations
- Computer Interfaced Software
- High Temperature Heat Shield
- SEM single, "Dual Range" Sensors CO and/or NO

ENERAC 1300 Shames Drive, Westbury, NY 11590
(516) 997-2100 • 1-800-695-3637 • Fax: (516) 997-2129

SEM

CHAPTER 1

FUNDAMENTALS

The ENERAC Model 3000 Integrated Emissions System is a portable state of the art analyzer designed for the following tasks:

A. **To measure the oxide of nitrogen emissions from stationary combustion sources in accordance with the EPA Provisional Reference Method (EMTIC CTM-022.WPF) for portable NOX analyzers.**

B. To measure the emissions of carbon monoxide, sulfur dioxide and gaseous combustibles and oxygen from stationary and mobile combustion sources.

C. (OPTIONAL) To measure the stack gas velocity and volumetric flow rate and emission rates according to Method 2 Appendix A of 40CFR60.

C. To assist the operator of a combustion source with the task of optimizing its performance and saving fuel.

D. To be used as a management tool to assist the plant manager with keeping records and controlling costs.

The ENERAC Model 3000 is the most advanced instrument of its type. It uses the latest proprietary (SEM INSIDE (TM)) electrochemical sensor technology to measure emissions. To meet the accuracy requirements of the EPA reference methods each SEM sensor is supplied with three Precision Control Modules whose function is to select the measurement range (low, mid and high) that is appropriate for a particular measurement.

The ENERAC also uses the best available conditioning system technology (proprietary permeation drier configuration) for accurate transport of the sample gas to the instrument. It also uses sophisticated electronics and programming design for increased accuracy and flexibility. It measures 3 temperatures and 6 different stack gases. It computes efficiency of combustion as well as excess air

and carbon dioxide. In addition, it computes emissions in five different systems of units (ppm, milligrams/m3, lbs/MMBTU, grams/brake horsepower -hour and lbs / hour). It stores, prints and plots data. It communicates with a variety of other computers located near by via its RS-232 port, or remotely by telephone connection. It has a library of 15 fuels and over 100 diagnostic and help messages and can operate either on its rechargeable batteries, AC power, or from an external 6 Volt battery, or an 11-36 VDC (external battery system).

ENERGY EFFICIENCY SYSTEMS has years of experience in the manufacture and marketing of combustion and portable emission analyzers. The model 3000 is based on this experience, together with the latest innovations in electronic and sensor technology. It also expresses our basic conviction that communications and artificial intelligence are the basic ingredients of the instrument of the future.

The instrument operates basically as follows:

You select a sensor module (CO, NO and SO2) whose range is appropriate to the measurement and set the Enerac for the chosen modules. You then insert the probe in the stack of an operating combustion source such as a boiler, furnace or combustion engine. A pump located inside the instrument draws a small sample of the stack gas. The sample is conditioned before entering the analyzer. A number of sensors analyze the contents of the stack gas and its temperature and calculate and display the results. The results can also be printed, stored or send to another computer either by direct connection or by the telephone lines. The source operator makes the required adjustments based on the analysis of the stack conditions to optimize performance.

A. UNPACKING THE INSTRUMENT

Every ENERAC model 3000 includes as standard equipment:

1. One Emissions Analyzer model 3000 (includes a roll of printer thermal paper).

2. One stack probe and permeation drier housing.

3. One 14" inconel probe extension and Hastelloy X sintered filter.

CHAPTER 11

CALIBRATION

Every instrument must occasionally be calibrated against some known value of a parameter in order to make sure that its accuracy has not deteriorated.

The instrument software make sure that the display readout is always a linear function of the source excitation (i.e. gas concentration or temperature etc.). You therefore need only two points on the straight line to calibrate a parameter over its entire range. Usually, the first point chosen is the zero value (called zeroing the instrument). The second point has to be set by using some known value of the parameter being calibrated (i.e. using for example 200 PPM certified carbon monoxide gas to set the display to read 200). Sometimes the second point is not needed, if the slope of the parameter is known and is always the same (for example for the stack temperature the slope of the curve is well known and you don't need a span calibration).

Traditionally, both zeroing and span (i.e. second point) calibration was done manually, by rotating suitable potentiometers until the display was set to read first zero in ambient air and then the correct value using span gas.

With the introduction of microprocessors, it became a simple matter for instruments to zero themselves automatically upon start up (AUTOZERO) , without having to use any adjustments However, this simplification requires caution. The instrument must be started in a true "zero" environment. Otherwise it will assume as "zero" non zero conditions and give erroneous readings. (Example: Never autozero the ENERAC, if the probe tip is still hot following a recent measurement.)

The ENERAC carries out this improvement in automatic calibration procedure one step further. It does away with all potentiometric span adjustments. You just tell it the value of the calibrating parameter that you are using and the instrument adjusts itself automatically.

In addition, it carries out a systematic checkout of sensor performance and instrument integrity through a novel approach called the "ENERAC

CALIBRATION PROTOCOL". This protocol is explained below.

The ENERAC will "auto zero" itself every time you start the instrument, provided you push the ENTER key. Span calibration will be carried out on request.

You should carry out a span calibration every 3-4 months to maintain an instrument accuracy within specifications. Some regulatory requirements specify that a span calibration be carried out before each measurement. In that case you may find the EES portable calibration kit very useful.

A. THE ENERAC CALIBRATION PROTOCOL

To maintain the integrity and accuracy demanded of a regulatory compliance apparatus, the ENERAC 3000 has been given an extensive and comprehensive "calibration protocol", that will appear on its printer every time a calibration is carried out.

The protocol checks both instrument zero and span performance and serves to instill to the operator confidence on the integrity of his data.

1. The autozero protocol.

Every time the ENERAC is autozeroed, the performance of the sensors is checked to make sure that sensor zero baselines are within the prescribed limits.

If one or more of the sensors are outside the specified limits a message will appear on the display and printed simultaneously on the ENERAC's printer for documentation.

2. The span calibration protocol.

Since the calibration protocol checks the sensor's selectivity against interfering gases, you must always use SINGLE TOXIC GAS MIXTURES (i.e. do not use mixtures containing two of the following gases in one cylinder: carbon monoxide, nitric oxide, nitrogen dioxide and sulfur dioxide).

(The only exception to the SINGLE TOXIC GAS rule is to use a blend of NO and SO2 gas bal. Nitrogen, in order to determine the performance of the NO sensor filter media. Cross interference of the NO sensor to SO2 gas is detected only, if NO gas is present! Do not use, however, this blend to carry out any calibrations. Use it just to check sensor response.)

Every time the ENERAC is calibrated using span gas, a number of different parameters are checked for satisfactory performance.

The following messages appear always on the ENERAC printer:

"ENERAC CALIBRATION PROTOCOL"
" TIME: XX:XX:XX   DATE: XX/XX/XX"

followed by a series of messages.

a. Air leak check.

The instrument is checked for air leaks during span calibration.

The air leak check is carried out only when calibrating the NO sensor, since NO span gas must always have zero oxygen.

If a leak is detected the following messages appear on the printer:

"SENSOR CALIBRATION FAILED"
"DETECTED SYSTEM AIR LEAK"

If an air leak is discovered, first check the gas connection to the tip of the probe to make sure that it is air tight. Following this, determine if the leak is in the probe or in the instrument. You can do this by passing the probe and feeding the gas to the instrument directly. Contact EES for further assistance.

b. Sensor sensitivity check.

The output of the sensor undergoing calibration is checked against its original sensitivity that has been stored in its memory. If the sensor's sensitivity is within the acceptable limits, the following message appears on the printer:

"SENSOR CALIBRATION SUCCESSFUL"
"XX SENSOR OK"

where XX refers to the sensor being calibrated.

If the sensor's sensitivity is slightly outside acceptable limits, but the sensor is still functioning properly, the following messages appear on the printer:

"SENSOR CALIBRATION SUCCESSFUL"
"REPLACE XX SENSOR SOON OR CHECK GAS"

The purpose of the last message is to warn the operator that the sensor might soon need replacement, or that the wrong span gas value has been entered accidentally.

Be careful when calibrating the NO2 sensor with span gas. NO2 span gas concentration deteriorates with time. Don't use any cylinders that are more than 6 months old. Buy from a reputable supplier. Don't use any external desiccants or water traps.

If the sensor's sensitivity is considerably outside acceptable limits, the sensor is considered as not functioning properly and should be replaced. The following messages appear on the printer:

"SENSOR CALIBRATION FAILED"
"REPLACE XX SENSOR OR CHECK SPAN GAS"

c. Sensor selectivity check.

The Precision Control Modules of the CO, NO and SO2 sensors have long life inboard filters to remove any interfering gases that may be present in the

sample.
Filter life depends on the sensor, the concentration of the gas and exposure time of the interfering gas. Typically, for the ENERAC's SEM sensors it is 200,000 PPM-hours for the CO sensor and 20,000 PPM-hours for the NO sensor to NO_2 gas and 70000 PPM-hours to SO_2 gas.

If the cross sensitivity of the interfering gas rises to 2% for CO or 6% for NO the following warning message will appear on the printer:

"REPLACE XX SENSOR FILTER SOON"

If the cross sensitivity of the interfering gas rises further (i.e. 5% for the CO sensor) the following message will appear on the printer:

"REPLACE XX SENSOR FILTER "

Please keep in mind that irrespective of the inboard filter performance, the ENERAC mathematically compensates for any residual cross sensitivity, so that measurements can be taken with reasonable accuracy (but not compliance level accuracy), even if the filters need replacement.

B. AUTO ZEROING THE INSTRUMENT.

Every time you turn the instrument on, you should wait for 2 minutes for the ENERAC to warm up(OR UNTIL THE GREEN "PROBE OK LED TURNS ON). At the end of the warmup period the ENERAC reads the output of all sensors and sets them all to zero with the exception of the oxygen that it sets to 20.9%. (The ambient temperature is read directly). Consequently, it is very important that at the moment of "zeroing" the probe tip is at room temperature and the environment is clean from traces of carbon monoxide or other gases.

NOTE: In practice AUTOZEROING is only needed once at the beginning of a day of measurements. The ENERAC will not have sufficient zero drift during the next 24 hours to require additional autozeroing procedures.

You can bypass the AUTOZERO procedure by pressing any key other than the "ENTER" key, when prompted to do so by the display.

If the instrument has not been used for quite some time, it is a good idea to give it a longer warmup period. To do this turn the unit off at the end of its initial warmup and then turn it immediately back on.

If you accidentally shut off the unit, while the probe is still in the stack, turn the unit back on and bypass the Autozeroing procedure by pressing any key other than the
"Enter" key when the message "press enter to autozero" appears.

C. INSTRUMENT SPAN CALIBRATION.

Ideally, you should span calibrate the instrument every time you replace a Precision Control Module. At a minimum, once every 3-4 months you should perform a span calibration of the instrument. The parameters that require a span calibration are: carbon monoxide, combustibles, nitric oxide, nitrogen dioxide and sulfur dioxide.

There is, also, a span calibration for the ambient temperature sensor.

For instruments that have the stack-velocity (S-V) option, there is an additional calibration of the very low pressure sensor and a command to adjust the Pitot tube factor.

You can carry out all span calibrations in sequence or just one only, if you wish.

You can use your own span gas, or if you need to calibrate the ENERAC in the field, you can use the convenient gas calibration kit supplied by Energy Efficiency Systems.

1. Span calibration using the EES kit.

The gas calibration system supplied by EES is shown in Fig. 9. The kit comes with a gas cylinder containing a mixture of 200 PPM carbon monoxide (typically), 1.0% methane and balance nitrogen. For NO, NO2 and SO2 calibrations you must order extra gas cylinders containing the desired type of span gas. All four gas cylinders and apparatus fit inside a

carrying case for easy transportation to the field.

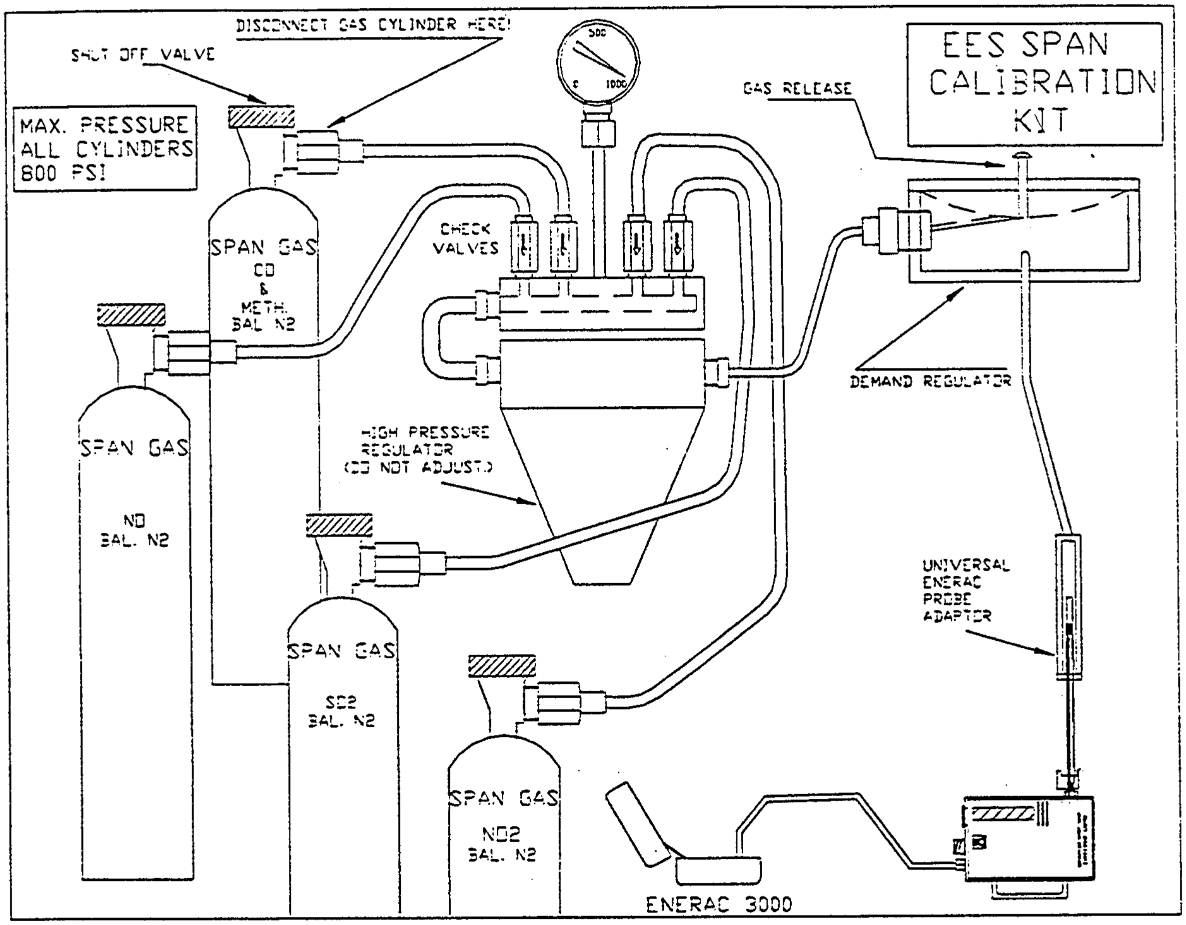


FIGURE 9

Follow the instructions supplied with the calibration kit for proper span calibration.

For the span calibration of the AMBIENT TEMPERATURE follow the directions in section 2 below.

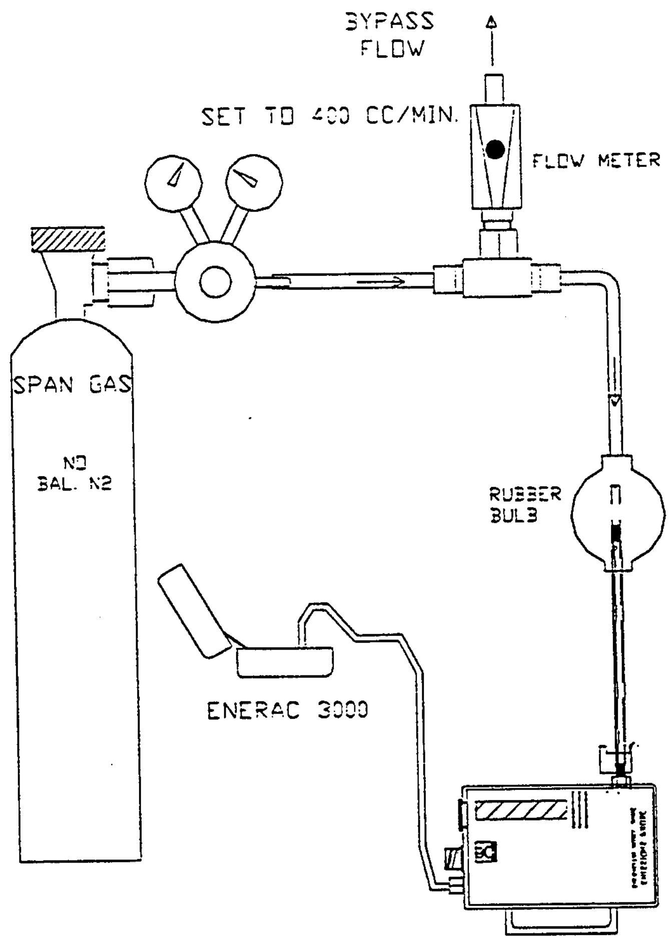
2. Span calibration using your own gas.

If you wish to use your own gas to perform span calibrations you must take

certain precautions, in order to calibrate the sensors properly.

Preferably, for greatest accuracy it is recommended that you use a span gas value close to the emission concentration you expect to measure.

To carry out a span calibration USING YOUR OWN GAS APPARATUS



(Use single toxic gas mixture!)
FIGURE 10

follow the steps below:

1. Set up your calibration apparatus as shown in fig. 10.

Notice that you need a number of certified gas cylinders. Make sure you use the calibration accessory supplied with your instrument. The accessory ensures proper gas flow to the ENERAC.

You must not feed gas to the ENERAC under pressure and you must not starve the ENERAC's pump for gas. When feeding the gas to the ENERAC you must maintain the pressure reasonably constant. This is a requirement of all diffusion type sensors.

Connect the calibration accessory to the ENERAC probe. Make sure the rubber bulb is inserted past the square grooves located at the probe tip.

Connect the other end of the calibration accessory to the gas cylinder.

Make sure the concentration of the calibration gas is within the range of the Precision Control Module selected for each sensor. <u>Do not under any circumstances, use gas that will over range the PCM</u>. Preferably, do not calibrate with gas whose concentration is lower the PCM's range's lower boundary.

The Carbon Monoxide gas can be in the range 30-20000 PPM 2% accuracy with the balance nitrogen, preferably.

The Combustible gas can be in the range 0.07%-3.0% methane, 2% accuracy with the balance nitrogen or air.

The NO span gas can be in the range 10-3500 PPM, 2% accuracy with balance nitrogen.

The NO2 span gas should be in the range 50-500 PPM, 2% accuracy balance air, preferably.

The sulfur dioxide span gas can be in the range of 30-7000 PPM, 2% accuracy, balance nitrogen, preferably.

If you plan to calibrate all sensors, follow the order of their appearance on the display. This is desirable in order to set the compensating matrix for cross sensitivities, properly.

2. Turn the instrument on, press ENTER to autozero and wait until the following message appears on the display:

"INSERT PROBE"

3. Push the "SET" button and observe "SET" LED turn on.

4. Push the "NO/NO2" button. The following message will appear:

"CMB SPAN GAS: 0.11%"

Step #5 below demonstrates how to by pass an unwanted span calibration and proceed to the next one.

5. (If you wish to skip the Combustibles calibration push the "ENTER" button. The display will read :

"PUSH ENTER KEY!!".

Press any button, except the "ENTER" button and the unit will skip the combustibles calibration and proceed to the next one.)

6. To carry out the combustibles span calibration, use the "UP" or "DOWN" buttons until the display reads the same combustibles value as that printed on the combustibles (methane) gas cylinder label. Then press the "ENTER" button. The following message will appear on the display:

"PRESS ENTER KEY!!"

7. Open the span gas valve and set your gas bypass flow (as indicated by the small flow meter of the calibration accessory) to 200-400 cc/min Make sure the flow rate indicated is reasonably constant. Press the "ENTER" key. The following message will appear on the display:

"FEED GAS NOW and WAIT"

8. Make sure you keep the gas flow reasonably constant by monitoring the flow meter. At the end of approximately three minutes the ENERAC will record and store the combustibles sensor response and define it as the value that you set earlier on the display.

When the following message appears on the display:

"CO SPAN GAS: 200 PPM"

it means that you are finished with the combustibles span calibration and the instrument is prompting you to perform the CO calibration next. Shut off the gas!

9. To carry out the CO (carbon monoxide) span calibration follow the procedure outlined above for the combustibles calibration.

A number of important messages, that are part of the "ENERAC CALIBRATION PROTOCOL", will appear on the printer at the end of the CO calibration.

If you wish to skip the CO sensor calibration proceed as in step 5. The following message will appear on the display:

"NO SPAN GAS: 200 PPM"

prompting you to carry out this calibration.

Please note that according to "ENERAC Calibration Protocol" this calibration also checks the performance of the CO sensor filter.

You may carry out or by pass this calibration, as you wish.

10.The next sensor calibration in line is sulfur dioxide and the following message will appear on the display;

"SO2 SPAN GAS: 200 PPM"

If you wish to carry out any of these calibrations, proceed as outlined in steps 6, 7 and 8.

IMPORTANT NOTE: SO2 AND NO2 gases are "sticky" gases. That means

that they tend to adsorb partially to the surface of materials causing a slow down of the response time of the instrument. For this reason, it is a good practice when calibrating with SO2 or NO2 span gases, to begin feeding the gas at least four minutes before executing the span calibration!

11. The last sensor calibration to be carried out is nitrogen dioxide and the following message will appear on the display:

"NO2 SPAN GAS: 100 PPM"

prompting you to carry out this calibration in turn.

Please note that this span calibration also checks the performance of the NO sensor inboard filter and in addition, the performance of the SO2 sensor according to the "ENERAC Calibration Protocol".

At the end of all span gas calibrations the following message will appear on the display:

"ATEMP OFFSET +0 C"

12.The final span calibration corrects for any inaccuracy in the ambient temperature reading. This calibration allows you to make minor corrections so that the ENERAC will read the exact ambient temperature.

You can only enter the correction in degrees Celsius. Use a good thermometer to compare with the ENERAC's ambient temperature reading and correct accordingly.

At the end of the span calibration procedure the following message will appear on the display:

"WAIT TWO MINUTES!!"

The instrument is now purging any traces of remaining gas.

At the end of the two minute period it will perform an "auto zero" and it will

be ready for measurements by displaying any two stack parameters.

NOTE: IF you wish to exit the span calibration procedure at any time, other than when the message "FEED GAS AND WAIT" is displayed simply press the "SET" key and observe the "SET LED" turn off.

Whenever the message "FEED GAS NOW AND WAIT" appears, the ENERAC is inside a software loop and will not respond to any keys or communicate with external computers. SHUT THE INSTRUMENT OFF, IF YOU HAVE TO ABORT A SPAN CALIBRATION.

INCREASED ACCURACY REQUIREMENTS

1. ALLOW THE INSTRUMENT TO REACH AMBIENT TEMPERATURE BEFORE CARRYING OUT A SPAN CALIBRATION OR MEASUREMENT.

2. FOR NO, NO2 AND SO2 CALIBRATIONS, FEED THE SPAN GAS FOR A MINIMUM OF 10 MINUTES BEFORE EXECUTING THE SPAN CALIBRATION PROCEDURE.

3. DURING A MEASUREMENT MAINTAIN THE SAME FLOW RATE INTO THE INSTRUMENT (+/- 10%) AS DURING SPAN CALIBRATION BY ADJUSTING THE SAMPLE PUMP VOLTAGE, IF NECESSARY.

4. TO ACHIEVE THE BEST MATHEMATICAL COMPENSATION, USE NO2 SPAN GAS TO CALIBRATE, WHOSE CONCENTRATION IS APPROXIMATELY THE AVERAGE CONCENTRATION OF YOUR EXPECTED EMISSION.

5. CHECK THE NO FILTER INTERFERENCE REJECTION OF SO2 GAS BY FEEDING A BLEND OF KNOWN CONCENTRATIONS OF no AND SO2 GASES.

MEASURED PARAMETERS:

1.	AMBIENT TEMPERATURE.	IC sensor. Degrees F or C. Range: 0-150 degrees F Resolution: 1 degree F or C. Accuracy: 3 degrees F
2.	STACK TEMPERATURE.	Type K thermocouple. Degrees F or C Range: 0-2000 degrees F (1100 C). Resolution: 1 degree F.(1 C.) Accuracy: 5 degrees F.
3.	OXYGEN.	Electrochemical cell. Life 2 years. Range: 0-25% Resolution: 0.1% Accuracy: 0.2%
4.	NITRIC OXIDE(NO).	Electrochemical (SEM (TM)) cell. Life 2 years. PCM Ranges: 0-300 PPM. 0-1000 PPM (300-1000) 0-3500 PPM (1000-3500) Resolution: 1 PPM Accuracy: 2% of reading (*)
5.	NITROGEN DIOXIDE(NO2).	Electrochemical (SEM (TM)) cell.Life 2 years. Range: 0-500 PPM. Resolution: 1 PPM Accuracy: 2% of reading (*)
6.	CARBON MONOXIDE.	Electrochemical (SEM (TM)) cell. Life 2 years. PCM Ranges: 0-500 PPM. 0-2000 PPM (500-2000) 0-20000 PPM (2000-20000) Resolution:1 PPM

Accuracy: 2% of reading (*)

7. SULFUR DIOXIDE. Electrochemical (SEM (TM)) cell. Life 2 years.
PCM Ranges: 0-500 PPM.
0-2000 PPM (500-2000)
0-7000 PPM (2000-7000)
Resolution:1 PPM
Accuracy: 2% of reading (*)

8. COMBUSTIBLES(GASES). Catalytic sensor. Life indefinite.
Range: 0-6.00%
Resolution:0.01%
Accuracy:10% of reading in CH4 gas

9. TIME/DATE. Time in hours,minutes,seconds. Date in month, day,year format.

(*) When tested according to 40CFR60, RAA test.

COMPUTED PARAMETERS:

1. COMBUSTION EFFICIENCY. Heat loss method. Unique four loss factors computation.
(dry gas, water vapor, gaseous combustibles,combustibles in ash)
Range: 0-100%
Resolution:0.1%
Accuracy(4 loss): 1% (above H2O condensation)
2% (below H2O condensation)

2. CARBON DIOXIDE. Range:0-40%
Resolution:0.1%
Accuracy:5% of reading.

3. EXCESS AIR. Range: 0-1000%
Resolution: 1%
Accuracy: 10% of reading

4. OXIDES OF NITROGEN. PCM Ranges: 0-800 PPM.
0-1500 PPM (800-1500)
0-4300 PPM (1500-4300)
Resolution: 1 PPM
Accuracy: 2% of reading (*)

5. EMISSIONS 1. (CO, NO, NO2, NOX, SO2) Range: 0-2500 milligrams/cubic meter
Resolution: 2 mg/m3
Accuracy: 5% of reading

6. EMISSIONS 2. (CO, NO, NO2, NOX, SO2) Range: 0.000-99.99 lbs./million BTU
Resolution: 0.01 lbs./MMBTU
Accuracy: 5% of reading

(Oxygen correction factor for emissions adjustable 0-20% in 1% steps plus TRUE).

7. EMISSIONS 3. Range: 0-99.99 grams/brake hp-hr
Resolution: 0.01 grms/bhp-hr
Accuracy: 10% of reading

PRINTER:

SEIKO 4",40 char. per line thermal printer with form feed and line feed buttons and with end of paper override.

Operates in any of four print modes:

1. TEXT MODE. 25 line printout of instant. values of all measured parameters. (time req.20 sec.)
2. PLOT MODE. Any one parameter vs. time plotted.
3 ordinate scales: full, half,quarter.
Time scale: Selectable,1 sec/dot-1 min/dot in 1 sec/dot intervals.

APPENDIX I

Example Calculations

Example Calculations

1. Determine the mass emission flow rate (lbs/hr) of carbon monoxide from the SUE Incinerator during exhaust Sampling Run # 2.

$$E = (C) \times (MW) \times (FR) \times (1.55\text{x}10^{-7})$$

Where,

E = The pollutant emission rate in pounds per hour (lb/hr)
C = The measured pollutant concentration in parts per million by volume (ppmv). For Run # 2, the average CO concentration was 108 ppmv.
MW = The molecular weight of the pollutant. For CO, MW = 28
FR = The flow rate of the stack gas in dry standard cubic feet per minute (DSCFM). The flow rate for Run # 2 (as calculated by EPA's HP 41 "Meth 2" Calculator Program) was 9,097 DSCFM.
$1.55\text{x}10^{-7}$ = Conversion Factor $[(\text{min}\cdot\text{g-mole}\cdot\text{lb})/(\text{hr}\cdot\text{g}\cdot\text{ft}^3)]$

$$E = (108)(28\ \text{g/g-mole})(9{,}097\ \text{ft}^3/\text{min})(1.55\text{x}10^{-7}\ \text{min}\cdot\text{g-mole}\cdot\text{lb/hr}\cdot\text{g}\cdot\text{ft}^3)$$

E = 4.3 lbs/hr

2. Determine the VOC destruction efficiency of the SUE Incinerator during exhaust Sampling Run #1.

$$DE = [(CF - E_{ex})/CF] \times 100$$

Where,

DE = Destruction Efficiency (%)
CF = Calibration fluid combusted by the SUE Incinerator (lb/hr as Stoddard solvent). This includes both the VOC vapors in the inlet gas stream and the liquid waste calibration fluid burned as supplemental fuel.
E_{ex} = VOC emission rate in exhaust stack (lb/hr as Stoddard solvent).

Since the SUE Incinerator burned liquid waste calibration fluid, it is necessary to determine both the inlet and exhaust VOC mass flow rates in units of "lbs/hr as Stoddard solvent" instead of "lbs/hr as propane." This is done by converting the measured concentrations from "ppmv as propane" to "ppmv as Stoddard solvent" using the following equation:

ppmv as Stoddard solvent = [(ppmv as propane) x (3)]/7.05

Where,

3 = the carbon equivalent correction factor (listed in EPA Method 25A) which converts "ppmv as propane" to "ppmv as carbon"

7.05 = response factor (determined by a contractor during previous VOC emissions testing at Kelly AFB) for converting "ppmv as carbon" to "ppmv as Stoddard solvent)

Average inlet VOC concentration = (149 ppmv as propane)(3)(1/7.05)
= 63.4 ppmv as Stoddard solvent

Run 1 exhaust VOC concentration = (14.7 ppmv as propane)(3)(1/7.05)
= 6.3 ppmv as Stoddard solvent

The inlet and exhaust VOC mass emission rates (in lbs/hr as Stoddard solvent) are then calculated as follows:

$$E = (C) \times (MW) \times (FR) \times (1.55\text{x}10^{-7})$$

Where,

E = The pollutant emission rate (lbs/hr as Stoddard solvent)

C = The pollutant concentration (ppmv as Stoddard solvent)

MW = The molecular weight of the pollutant. For Stoddard solvent, MW = 140

FR = The flow rate of the gas stream (DSCFM). The average inlet flow rate (as calculated by EPA's HP 41 "Meth 2" Calculator Program) was 10,085 DSCFM. The Run 1 exhaust flow rate (as calculated by EPA's HP 41 "Meth 2" Calculator Program) was 9,155 DSCFM.

$1.55\text{x}10^{-7}$ = Conversion Factor [(min·g-mole·lb)/(hr·g·ft^3)]

E (in) = (63.4)(140 g/g-mole)(10,085 ft^3/min)($1.55\text{x}10^{-7}$ min·g-mole·lb/hr·g·ft^3)
= 13.9 lbs/hr as Stoddard solvent

E (ex) = (6.3)(140 g/g-mole)(9,155 ft^3/min)($1.55\text{x}10^{-7}$ min·g-mole·lb/hr·g·ft^3)
= 1.25 lbs/hr as Stoddard solvent

The average inlet VOC mass flow rate (13.9 lbs/hr as Stoddard solvent) is then added to the liquid waste Stoddard solvent combusted during exhaust Sampling Run # 1 (108 lbs/hr) to obtain the approximate amount of total calibration fluid (121.9 lbs/hr) combusted during Run # 1. The destruction efficiency can now be calculated as follows:

DE = [(121.9 lb/hr - 1.25 lbs/hr)/121.9 lbs/hr] x 100

DE = 99.0%